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Development of a supply chain management framework for health care goods provided as humanitarian assistance in complex political emergencies

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Development of a supply chain management framework for health care goods provided as humanitarian assistance in complex political emergencies

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ABBREVIATIONS AND ACRONYMS

ALITE	Augmented Logistics Intervention Team
ALNAP	Active Learning Network on Accountability and Performance
CCC	Customs Cooperation Council
CP	Consolidation Point
CP/DP	Consolidation and Distribution Point
CPE	Complex Political Emergency
DC	Developed Country
DP	Distribution Point
ECHO	European Community Humanitarian Office
EDI	Electronic Data Interchange
EPI	Expanded Programme on Immunization
FEFO	First-expiry/first-out
FIFO	First-in/first-out
GMP	Good Manufacturing Practices
HA	Humanitarian Assistance
HCG	Health Care Goods
HF	High frequency
HIIK	Heidelberg Insitute for International Conflict Research
HO	Humanitarian Organization
IASC	Inter-Agency Standing Committee
IATA	International Air Transport Association
ICRC	International Committee of the Red Cross
IDC	International Distribution Centre
IDP	Internally Displaced Person
IFRC	International Federation of Red Cross and Red Crescent Societies
IHL	International Humanitarian Law
INN	International Nonproprietary Name
IRU	International Relief Union
LDC	Less Developed Country
LLDC	Least Developed Country
MRO	Maintenance, repair and operating
MsF	Médecins sans Frontières

NDC	National Distribution Centre
OCHA	Office for the Coordination of Humanitarian Affairs
ODI	Overseas Development Institute
OECD	Organisation for Economic Co-operation and Development
OXFAM	Oxford Famine Relief
PAHO	Pan American Health Organization
pH	Potential of hydrogen
PHC	Primary Health Care
QA	Quality assurance
RDC	Regional Distribution Centre
SC	Supply Chain
SCM	Supply Chain Management
SUMA	Humanitarian Supply Management System (WHO/PAHO)
TOR	Teleprinter Over Radio
UN	United Nations
UNCTAD	United Nations Conference on Trade and Development
UNDAC	United Nations Disaster Assesssment and Coordination
UNHCR	United Nations High Commissioner for Refugees
UNICEF	United Nations Children's Fund
UNJLC	United Nations Joint Logistic Centre
UNRRA	United Nations Relief and Rehabilitation Administration
USP	United States Pharmacopoeia
VEN	Vital - essential - non-essential
VENRO	Verband Entwicklungspolitik Deutscher Nichtregierungsorganisationen
VHF	Very high frequency
WFP	World Food Programme
WHIS-RAD	World Health Imaging System for Radiography
WHO	World Health Organization

ABSTRACT

Every year millions of civilians affected by complex political emergencies worldwide require outside humanitarian assistance during the emergency as well as the reconstruction and rehabilitation phase. Professional logistics and supply chain management is indispensable for providing high quality health care goods to health care facilities treating wounded and sick people.

While extensive literature is available on all aspects of commercial logistics and supply chain management and some publications deal with logistics management of health care goods in less developed countries, the literature on logistics management in complex political emergencies in general and health care goods in particular is very limited.

This applied research attempts to develop a coherent and comprehensive supply chain management framework for health care goods provided as humanitarian assistance in complex political emergencies which will allow improving the effectiveness and efficiency of humanitarian assistance programmes.

The research design is based on a detailed literature analysis of the objectives of humanitarian organizations and their assistance programmes as well as an analysis of the context and constraints of complex political emergencies and less developed countries. Together with the implications of the characteristics of health care goods, ten logistics and supply chain management objectives for humanitarian assistance are deduced. These are summarized into cost (resources), risk (insecurity) and reduction of suffering (customer service) in order to analyse the trade-offs between them.

The two dimensions of management levels and logistics processes of Thorn's framework are extended by the aspects of time, distance and criticality. The time aspect concerns the emergency, rehabilitation and reconstruction as well as development phase. The distance from the conflict area is related to changing levels of safety and security risks as well as the differences between developed and less developed countries. Finally the aspect of criticality of items considers the importance of items and the detrimental consequences of shortages and stockouts.

Within these dimensions, heuristics and reasoning is used to apply or adapt commercial logistics and supply chain management concepts to the context and constraints which humanitarian organizations are subjected to in the context of complex political emergencies.

At the strategic level of supply network design the item selection strategy develops a framework for the use of kits and considers strategies for standardization and variety reduction. The importance of quality assurance and the need for its substitution is identified as the main determinant for developing a purchasing framework. A strategy for developing a facility network is proposed which favours a central distribution system within the country where humanitarian assistance is provided.

A framework for contingency planning and dynamically adjusting the positioning of emergency stocks within the supply network according to the development of the armed conflict is proposed.

The physical distribution strategy develops a framework for selecting different physical distribution channels as well as appropriate modes of transport.

The customer service strategy applies concepts and principles from commercial logistics and supply chain management to recipients and programme managers and stresses the importance of collaborative planning.

Finally the implications of the context of less developed countries as well as complex political emergencies on the selection of communication and information systems are analysed.

At the tactical level of supply chain planning, the concept of Essential Drug Lists is extended to other health care goods for developing the concept of programme standard lists.

The advantages and disadvantages of pre- and post-qualification of suppliers as well as different purchasing contracts are discussed and a framework for selecting different purchasing methods is developed.

The proposed inventory control system introduces the notion of multi-echelon systems into humanitarian supply networks and considers measures for reducing demand distortion throughout the supply network. A simple imprest system is proposed at the level of assisted health care facilities. For replenishment of medical stocks managed by humanitarian organizations a (R, S) policy and for emergency stocks a (S-1, S) policy is proposed for. Another framework is developed for deciding on stock positioning of items at different tiers of the supply network.

The options of direct shipment, transhipment, cross-docking as well as lateral transhipment and criteria for selecting suitable modes of transport are elaborated on.

Finally the development of customer service plans which are tailored to the needs of individual humanitarian assistance programmes is suggested.

At the tactical level the transition from using of a "push" system during the initial emergency phase to a "pull" system during the development phase is proposed. Operational issues concerning purchasing, storage and distribution focus on maintaining the quality of health care goods.

The proposed framework will allow humanitarian organizations to develop strategic, tactical as well as operational plans for providing logistic support to specific humanitarian assistance programmes within their constraints and in the context of the respective complex political emergency.

The extension of the proposed framework to other categories of humanitarian assistance goods such as food and household items or water and sanitation items as well as the areas of natural disasters and long-term development aid is conceivable.

1 RESEARCH OUTLINE

This introductory chapter will demonstrate the relevance of the research, narrow down the research topic and place it in context with related fields. After providing definitions of key terms the state of the field and important literature will be presented.

The discussion of the research problems, questions and objectives will be followed by a presentation of the research methodology and theoretical approach and the chapter will conclude with an outline of the research design.

1.1 Relevance of research

The objective of this research is to develop a supply chain management framework which will allow increasing the effectiveness and efficiency of humanitarian assistance in complex political emergencies.

Since the end of the Second World War a total of 228 armed conflicts in 148 locations throughout the world have been recorded, of which 118 took place in only 16 years after the end of the Cold War (Harbom, L., and P. Wallensteen 2005, 623).

During the fifty five years since the end of the Second World War 20 million people have been killed and 50 million injured in 160 major armed conflicts (Slim, H. 1997) and one hundred million people were forced to flee (Hanquet, G. (ed.) 1997, 7).

All of the worldwide 24 high intensity conflicts, two of them wars, and 74 crises with violent force in 2005 (HIIK 2005, 1) took place within rather than between states. 5.4 million people were internally displaced and an additional 9.2 million were refugees at the beginning of 2005 (UNHCR 2006, 13-14).

Most humanitarian assistance programmes include provision of a wide variety of humanitarian assistance goods such as food and potable water, shelter material and clothing, household articles as well as health care goods. Their selection, purchase, storage, transportation, distribution, quality assurance and tracking depend on effective, reliable and efficient logistics services. The logistical management is often made difficult by poor infrastructure in less developed countries as well as the insecurity caused by armed conflicts. Moreover the scarcity of humanitarian resources (Stockton, N. 2001, 11) as well as the pressure to increase the professionalism of all aspects of managing humanitarian assistance operations is a further reason for exploring opportunities of improving logistics and supply chain management.

Improving logistics services to humanitarian assistance programmes will help providing health care goods and services faster, more reliably, at an overall lower cost and to a larger number of people affected directly or indirectly by the consequences of armed conflict. This will in turn allow humanitarian organizations to respond to emergencies faster and provide health care services of higher quality more effectively and more efficiently to more people in need, especially in countries with chronically under-resourced health care services.

Ultimately the relevance and importance of this research lies in the potential to contribute to making logistics services an enabler, rather than being a constraint, and contribute to the reduction of mortality, morbidity, disability and suffering of people affected by armed conflicts.

1.2 Research topic

Supply chain management as well as humanitarian assistance are complex and vast topics which need to be limited (see figure 1.1) in order to fit the scope of a research project.

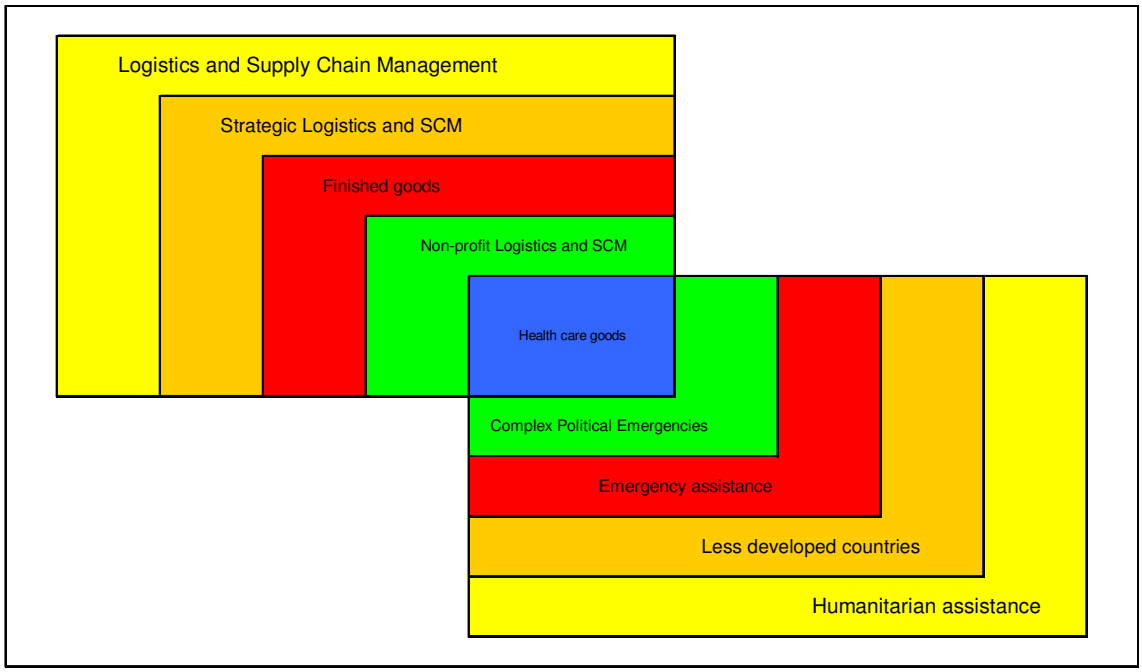

Figure 1.1 Narrowing down of the research topic

The research topic falls under the management science of logistics and supply chain management. Since the main objective is the development of a framework which is applicable to any humanitarian organization and any context, the research will deal primarily with strategic aspects and issues.

The research will be limited to the external supply chain of humanitarian organizations and therefore focus on management of finished goods rather than on production and manufacturing.

The research topic is further narrowed down to logistics and supply chain management in non-profit organizations, which humanitarian organizations are by definition. Nevertheless, many concepts of commercial logistics and supply chain management are of interest and applicable to the non-profit sector.

Although various concepts, principles and issues of humanitarian assistance are relevant and need to be analysed, this research does not deal with developing concepts for humanitarian assistance interventions but deals only with providing the required logistical support.

Humanitarian assistance may be provided in developed countries, for example in the aftermath of natural disasters. However since health services logistics concepts for developed countries have already been developed, this research will focus on the context of logistics and supply chain management in less developed countries. Developed countries will only be considered to the extent where supply chains span less developed as well as developed countries.

Since some concepts for logistics management in natural or technological disasters have already been developed, the topic is limited to the problems of logistics and

supply chain management in complex political emergencies. The research will also focus on humanitarian assistance provided during armed conflicts rather than during rehabilitation after armed conflicts or as part of development aid programmes. While supply chains will generally extend across countries and regions with different degrees of political stability, the research will focus on the context and situation of political instability and armed conflicts. As a consequence issues of international (humanitarian) law will need to be taken into consideration.

Finally the fields of logistics and supply chain management as well as humanitarian assistance are narrowed down to the core issue of managing health care goods. As in commercial logistics and supply chain management, the characteristics of classes of products must be considered in the development of a supply chain management strategy.

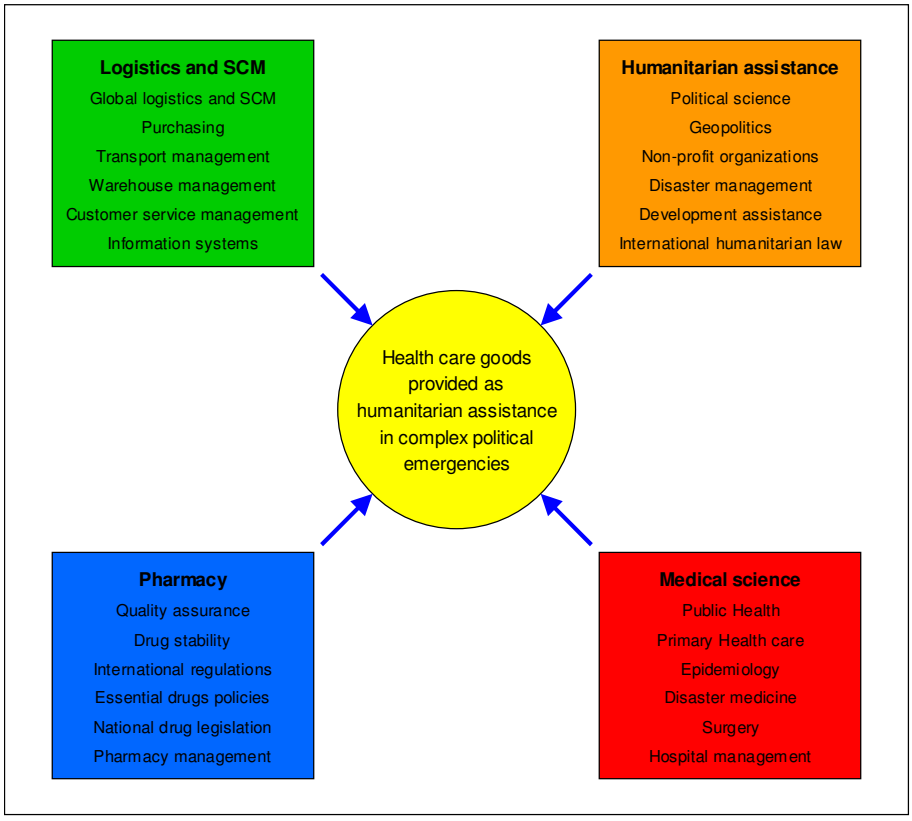

Figure 1.2 Fields related to the research topic

While people affected by complex political emergencies require a wide range of goods and services, the research will be limited to health care goods and services required for establishing and sustaining health care facilities and services. For example preventive services such as immunization campaigns or Mother and Child Health Care programmes as well as curative services such as treatment of war-wounded, clinical and hospital care. Consequently the research will have to consider the fields of public health as well as pharmaceutics. Figure 1.2 illustrates the fields which are relevant for the research topic.

1.3 Definitions

The definitions and explanations of the following critical terms are important for understanding the context of the research.

A large number of different definitions for logistics and supply chain management have been proposed without emergence of a universally agreed definition (Ehrmann, H. 2003, 25 and Stabenau, H. 2004, 141). While logistics concerns operational activities such as transportation and storage (Klaus, P., and W. Krieger (ed.) 2004, 294) and focuses on a single organization, supply chain management seeks to integrate and optimize the flows of goods and information across organizations from production until delivery to final customers (Waters, D. (ed.) 1999, 29).

For the context of natural and man-made disasters Thomas, A., and L.R. Kopczak (2005, 2) have defined humanitarian logistics as ". . . the process of planning, implementing and controlling the efficient, cost-effective flow and storage of goods and materials, as well as related information, from the point of origin to the point of consumption for the purpose of alleviating the suffering of vulnerable people". This definition also applies to complex political emergencies which are mainly man-made and often compounded by natural factors.

The worldwide 165 less developed countries differ from developed countries in, among others, lower standards of living, lower levels of economic development and education as well as shorter life expectancy (UNCTAD 2005, XI).

Events such as floods, earthquakes, tropical storms or droughts cause natural disasters while industrial or technological accidents as well as armed conflicts are considered as man-made disasters (Abdallah, S., and G. Burnham (ed.) 2000, 1-5).

Humanitarian disasters or emergencies which are caused by several factors have been termed "complex emergencies" (Abdallah, S., and G. Burnham (ed.) 2000, 33). Economic factors such as high levels of poverty, competition for water, territory and arable land as well as environmental degradation can cause or compound emergencies. Important social factors are overpopulation and population displacement as well as cultural, religious and especially ethnic differences. Finally disputed sovereignty (Gundel 1999, 13) as well as weakness or collapse of state authorities with subsequent violence are frequent political factors.

These factors, which sometimes can be cause as well as effect, often interact and compound each other (Mackinlay, J. (ed.) 1996, 19). For example overpopulation causing environmental degradation, leading to shortages of water and food and resulting in conflict. Conversely armed conflict may cause "green famines" when populations can no longer cultivate their land because of displacement or indiscriminate laying of land mines (Kalipeni, E., and J. Oppong 1998, 1638).

Complex Political Emergency (CPE) has emerged as a term to denote a humanitarian emergency which is largely caused by political factors (Milwood, D. (ed.) 1996, 6) and where lives and livelihoods are primarily threatened by high levels of violence and armed conflict (OECD 1999, 5). Unlike inter-state wars, complex political emergencies caused by "internal conflicts" or "civil wars", are often characterized by a multitude of different actors with various conflicting interests. Conflict research uses the threshold of one thousand deaths for defining civil wars (Mack, A. (ed.) 2005, 131).

Humanitarian assistance refers to the provision of material and technical aid in humanitarian emergencies as well as measures for protecting human rights of civilian populations (OECD 1999, 10). It is given to people in need without distinction as to race, ethnicity, creed, nationality, sex, age, physical or mental disability or political affiliation (EC 1257/96). Donors as well as providers, which may be individuals, governmental, non-governmental or international organizations are not motivated by making profits.

Potable water, food, sanitation, shelter, basic household goods and health care services (The Sphere Project 2004, 226) are provided with the primary objective of ensuring survival of the affected population, saving and protecting lives, preventing and alleviating suffering while respecting the dignity of the recipients (The Sphere Project 2004, 227).

As soon as the security situation permits and where necessary, humanitarian assistance is replaced by assistance for rehabilitation and reconstruction which in turn is followed by development aid although there is no clear dividing line between these three phases (OECD 1997, 10).

The final recipients of humanitarian assistance goods or services are usually individuals, commonly called beneficiaries. However, health care goods are mainly provided to health professionals or health care facilities which in turn use them to provide services to patients.

In a structured health care system three hierarchical levels of health services, which provide preventative and curative services as well as rehabilitation, can be distinguished (Perrin, P. 1996, 208). At the primary level family members, community health workers and traditional healers provide basic treatment for minor illnesses as well as first aid for injuries in the community. At the secondary level health care professionals provide outpatient services at simple health care facilities such as dispensaries, clinics or health centres. District as well as provincial hospitals constitute the tertiary level and provide treatment to outpatients as well as inpatients at the highest level. Other health services which are established for providing humanitarian assistance are first aid posts for treating war-wounded, orthopedic and rehabilitation centres, vaccination and therapeutic feeding centres, specialized facilities for treating large numbers of patients during cholera epidemics or mental health services.

Health care goods comprise a wide variety of drug products, expendable goods, medical devices, appliances and equipment used for preventative care, diagnosis, medical and surgical treatment as well as rehabilitation of patients.

1.4 State of the field

In order to position this research, a brief overview of relevant literature will be given and commented on. Literature which must be considered as non-scientific, such as operational and technical handbooks, is included since it constitutes an important part of available publications and these handbooks are very widely used by humanitarian organizations for training as well as during field operations. Moreover they point out important aspects and problems of logistics management in a context which is very rarely considered in academic literature.

While the areas of commercial logistics and supply chain management have been covered extensively by scientific publications, the literature predominantly refers to developed countries (Shawkey, P., and C. Hart 2003, 132) and hardly considers humanitarian assistance (Oloruntoba, R., and R. Gray 2003, 9).

Several publications deal with health services logistics in less developed countries. The very comprehensive book by Quick, J.D. (ed.) (1997) "Managing Drug Supply" is considered as the standard work and reference for establishing and managing public drug supply systems in less developed countries. Although procurement, storage and distribution of drug products are covered extensively, the publication focuses on health economics and policy issues as well as developing national distribution systems for public health services.

Dörner G. (ed.) (1992) published guidelines on all aspects of drug selection, procurement, storage, distribution and transport in less developed countries with a particular emphasis on quality assurance.

A wide range of logistics activities is covered in the handbook by Battersby, A. (1985) which aims at improving logistics management of primary health care programmes.

The World Health Organization (WHO 1997) has published comprehensive guidelines for quality assurance of drug products which in particular provide recommendations for quality assurance in pharmaceutical supply systems.

Shawkey, P. and C. Hart (2003) develop a framework for the context of less developed countries but only consider supply chain management of reproductive health products in times of peace.

A number of publications cover individual logistics activities such as purchasing and storage of health care goods in the context of less developed countries rather than management of the entire supply chain.

The World Health Organization (1999d) discusses strategic objectives and operational principles of good pharmaceutical procurement for public sector health systems. The World Health Organization (2002) also published practical guidelines for the procurement of drug products which discusses various different tender methods.

The Appropriate Health Resources and Technologies Action Group (1994) has published practical guidelines for management of small stores with simple means. Their publication covers planning and organization of stores, simple methods of inventory control as well as all procedures from receipt to dispatch of drug products and other health care goods. The World Health Organization (1998) published a document covering the same topics but focusing on training of staff.

Battersby, A. and A. Garnett (1993) discuss purchasing of drug products, inventory control as well as management of stores at national and regional levels. They also present a method for estimating storage and transport volumes as well as calculating storage requirements and designing warehouses. Similarly Chye, Y.B. (1988), who also compares centralized and decentralized purchasing strategies.

Marshal, A. (1995) describes the difficulties of sourcing and purchasing a large variety of health care and other products for a humanitarian assistance programme in Africa.

A range of publications considers logistics services for different levels of health care or for specific health services. The World Health Organization (1992b) develops recommendations for strengthening logistics support to Primary Health Care (PHC) programmes and stresses the importance of viewing logistics services as an integral part of the overall national health system.

The publication of Pearson, C.A. (1995) on management of hospitals in less developed countries covers operational issues of ordering health care goods as well as management of their storage and distribution at hospital pharmacies.

Compared to other groups of health care goods, a disproportionate large amount of literature is available on management of goods requiring a cold chain. Notably the Expanded Programme on Immunization (EPI) of the World Health Organization has published extensively on technical and operational aspects of providing vaccines to the general population in less developed countries, for example in WHO (1992a). Laurent, E. and H. Everts discuss storage and transport of vaccines during immunization campaigns.

"EPI Logistics and the cold chain: improving quality" (WHO 1990) assumes that logistics management of the cold chain is generally well established and discusses methods for monitoring performance and raising the quality of logistics services. The document also deals with technologies for injection, sterilization and refrigeration.

A conference report of the Technical Network for Logistics and Health (WHO 1990a) makes recommendations for improving management, planning supply systems as well as transport of vaccines. It also explores opportunities for integrating logistics management of vaccines into other Primary Health Care logistics services. A further report (WHO 1992a) discusses the development of information systems for demand forecasting as well as inventory control of vaccines, equipment and replacement parts. The following conference report (WHO 1993) discusses measures for improving country-wide distribution strategies and asks whether the "cold chain" could be replaced by a "fast chain". A concept for a global vaccine supply strategy, including trade-offs between international purchase and domestic production, is developed.

Several country studies describe and discuss distribution systems for drug products and give special consideration to national drug policies and legislation, implementation of essential drugs concepts, rational use of drugs as well as quality assurance of drug products. For example in Bangladesh (WHO 1985), Kenya (WHO 1985a), Papua New Guinea (Brudon-Jakobowicz, P., E. Lauridsen, R. Lunt, and T. Yoshtda 1986), Chile (Arango, J.I., P. Carlevaro, and G. Velasquez 1996) as well as Tunisia (Garraoui, A., P. Le Feuvre, and M. Ledoux 1999).

Haak, H., and H.V. Hogerzeil (1991) describe drug supply systems based on ration kits in great depth, analyse possible problems, discuss advantages and disadvantages and present an evaluation of kit programmes based on field studies in several less developed countries.

The World Health Organization (WHO 1992) presents several country programmes for emergency preparedness and discusses various aspects such as strategic planning and coordination.

Literature on logistics and supply chain management in the context of humanitarian assistance considers predominantly natural and technological disasters.

Tufinkgi, Ph. (2006) provides a detailed theoretical analysis of technological and natural disasters as well as disaster concepts and models. He determines the requirements, objectives and tasks of disaster logistics and points out shortcomings of current disaster logistics management. He makes proposals concerning risk analysis in disasters for determining logistic support needs, standardisation of marking and labelling of relief goods as well as for planning logistics networks.

A detailed report based on in depth research of humanitarian organizations, points to the similarities of the state of logistics in humanitarian assistance today with the situation of corporate logistics management 20 years ago (Thomas, A. 2003). The report analyses the main problems and challenges faced by humanitarian organizations and points to the need of realizing the strategic importance of logistics for disaster management. Fenton, G. (2003) makes the same comparison and points out that some humanitarian organizations still regard logistics services as an expense rather than a strategic management component. He also points out the problems caused by competition among humanitarian organizations and the problems which lack of coordination can cause. In another analysis Thomas, A. and L.R. Kopczak (2005) identify the lack of recognition of the importance of logistics, lack of professional staff, inadequate use of technology, lack of institutional learning and limited collaboration as the core challenges for humanitarian logistics.

The Center on International Cooperation with Lester Salamon and Associates (1999) assesses the preparedness capacities of international humanitarian organizations and stresses the importance of disaster preparedness for a quick and effective emergency response.

The East Africa and Great Lakes Region Inter-Agency Emergency Preparedness & Response Working Group (2004) discusses the potential for inter-agency collaboration of logistics services and has developed a logistics model for optimizing the material flows in humanitarian supply chains.

Forman, S. (1999) discusses the potential of cost savings by well-organized preparedness systems as well as the importance of immediate availability of funding for a quick emergency response of humanitarian organizations.

The European Commission (1998d) has published an academic text which seeks to apply management sciences to humanitarian assistance and devotes a short chapter to logistics which is limit to transport management.

Several articles discuss specific disaster situations and provide insights into the general challenges and constraints of logistics management.

Cassidy, W.B. (1999 and 1999a) stresses the importance of logistics service in the context of the humanitarian crisis in the Balkans and discusses some of the difficulties humanitarian organizations encountered during providing assistance to refugees. Freudmann (1999) discusses the differences between transport infrastructure and transport management outside and inside the conflict area.

Gustavsson, L. (2003) discusses problems caused by lack of adequate information systems. He also points out the lack of professional training, logistics expertise and skills of many humanitarian workers as well as the need to learn from the corporate sector.

Rickard, J. (2003) emphasizes the importance of information flow as well as the need for close coordination and collaborative planning between programme and logistics managers. The same point is stressed in the Field Handbook (UNDAC 2000) which devotes a chapter to disasters logistics and includes a detailed checklist for carrying out a logistics assessment.

The importance of involving logistics services early on in disaster response as well as the central role logisticians play in relief efforts in general is also stressed by Thomas, A. (2003a). Similarly Chaikin, D. (2003) points out that logistics management needs to be considered as a key support function and must be incorporated into planning at all stages of humanitarian assistance programmes.

Chomilier, B., R. Samii, and L.N.Van Wassenhove (2003) give an account of logistics management at the International Federation of the Red Cross and Red Crescent Societies in the aftermath of the Gujarat earthquake and point to the importance of standardization as well as establishing frame agreements with suppliers in advance as part of emergency preparedness plans.

The vital role of the freight industry for international humanitarian assistance programmes is pointed out by Lewis, Ch. (1999) who also discusses criteria for selecting different modes of transport.

McClintock, A. (1995) gives an account of the difficulties and complexities in providing humanitarian assistance goods to refugees in the aftermath of the genocide in Rwanda and emphasis the critical importance of information for logistics management.

Long, D. (1997) describes logistics management during the crisis in Northern Iraq and discusses various differences between the context of logistics management in commercial organizations in developed countries and during a humanitarian crisis in a conflict area. Similarly Gooley, T.B. (1999) describes differences between commercial logistics management and providing logistics services during the Balkan crisis.

Damas, Ph. (1997) describes the logistics strategy of the United Nations Children's Fund (UNICEF) which supplies more than 100 countries from its central Supply Division in Denmark and discusses the implications of using different modes of transport. The logistics of distributing assistance goods to more than one million children for UNICEF in Afghanistan in the immediate aftermath of an armed conflict is described by Molinaro, P., and S. Blanchet (2003).

Loane, G. (1998) points out that success or failure of humanitarian assistance operations are often determined by the effectiveness and efficiency of logistics services and gives an example of the importance of considering the political aspects of conflicts for logistics management in Somalia.

Gray, J. (1999) describes problems a commercial company encountered during providing air transport services to humanitarian organizations.

Scott-Bowden, P. (2003) explains the function of Augmented Logistics Intervention Teams for Emergencies (ALITE) which develop emergency preparedness plans, manage emergency stocks and provide logistics services to the World Food Programme. ALITE also coordinates activities with other humanitarian organizations and has developed relationships with the commercial sector to improve its logistics capacity and efficiency.

Humanitarian logistics management is often associated with food aid since transport of often large quantities over great distances is highly visible.

Bigman, D., and I. Weksler (1982) develop a framework as well as a mathematical model for emergency stocks which are established in anticipation of food shortages and famines.

The extensive study and evaluation of "Humanitarian Aid and Effects" (Milwood, D. (ed.) 1996) in response to the conflict in Rwanda devotes a chapter to logistics and compares advantages and disadvantages of airlifts versus overland transport of food. Likewise several United Nations agencies devoted a section to logistics management in their analysis of emergency operations in the Great Lakes area (UNHCR, 1998). The concept of close cooperation of agencies in the United Nations Joint Logistic Centre (UNJLC) and sharing of resources is discussed.

Huart, J.P. (1996) has published a handbook for food aid programmes which elaborates on a wide range of logistics management such as carrying out assessments, planning as well as purchasing, storing, transporting and distributing food. A similar publication by the United Nations High Commissioner for Refugees (UNHCR 1989) sets out standards for planning, carrying out, monitoring and controlling logistics operations. The Emergency Field Operations Pocketbook (WFP 2002) covers all aspects of providing food aid including purchase, storage and transport of food. CARE's Food Aid Logistics Operational Handbook (Hale, H. 1999) stresses the importance of supply chain management in guiding managers through all steps of providing food aid from determining food requirements, transport management, storage, delivery as well as calculating logistics costs.

Bennet, J. (2003) discusses the unexpected consequences of providing genetically modified food and points to the importance of carefully selecting humanitarian assistance goods as well as to the political dimension humanitarian assistance can

have. Since overseas donations were eventually rejected, logistics managers had to change their international supply strategy to a regional one on very short notice.

Vikki, M., and E. Bratheim (2003) analyse some of the problems encountered in large scale food distributions in Uganda and describes the "lean logistics" approach of several closely cooperating humanitarian organizations.

The management of health care goods provided as humanitarian assistance in the aftermath of natural disasters is discussed in a range of detailed publications.

Part of the publication "Emergency Health Management after Natural Disaster" (PAHO 1981) discusses the issue of emergency preparedness and devotes a chapter to logistics management of health care goods.

A further publication (PAHO 1983) emphasis the importance and priority of establishing a list of essential health care goods.

The Pan American Health Organization (PAHO) has published several books on disaster management with an emphasis on health services logistics management. It discusses, among others, the problems caused by inappropriate donations (PAHO 1999) and alternatives for donating assistance goods. Carballo, M., and D. Serdarevic (1997) also caution against use of drug donations and point out the advantages of drug kits. They also stress the importance of carrying out a sound assessment before implementing humanitarian assistance programmes and the critical importance of logistics management to sustain health care programmes. Similarly Musy, A. and D. Barras (1990) describes the kit policy of several humanitarian organizations and point out the advantage of being able to respond to disasters quickly.

An in depth discussion of principles of disaster mitigation in health care facilities, which have been struck by natural or technological disaster, was also published by the Pan American Health Organization (2000).

The publication "Humanitarian Supply Management and Logistics in the Health Sector" (PAHO 2001) discusses the assessment of available logistics resources, coordination between actors as well as all logistics activities necessary after natural disasters.

The Pan American Health Organization (2001b) has developed a computerized supply management system, called SUMA, which is mainly designed to record and track donated goods from the time of arrival in the country affected by a disaster until final distribution.

Several humanitarian organizations have published technical manuals or practical handbooks which are based on extensive field experience rather than scientific literature. They are intended for field staff, cover a wide range of aspects, principles and procedures for carrying out humanitarian assistance programmes and usually devote a chapter to logistics management.

For example "Assisting in emergencies: a resource handbook for UNICEF field staff" (Ockwell, R. A. 1994), "Handbook for emergencies" (UNHCR 2000), "The Oxfam Handbook of Development and Relief (Eade, D., and W. Suzanne, 1995), the "Handbook for emergency field operations" (WHO 1999c) as well as "Coping with Major Emergencies" (WHO 1996).

Other humanitarian organizations have published separate handbooks which are dedicated exclusively to logistics management or specific logistics activities. Among these are "Guidelines on logistics and transportation" (Canadian International Development Agency 2000), the "Logistics standards" (International Federation of Red

Cross and Red Crescent Societies 2000) as well as the "Logistics Field Manual" (International Committee of the Red Cross, 2004).

In summary a very comprehensive body of knowledge has been established for logistics and supply chain management which predominantly pertains to the commercial sector (A in figure 1.3) as well as for various aspects of logistics management of health care goods in less developed countries (B in figure 1.3).

A significant amount of literature has been published on logistics management in humanitarian emergencies after natural and technological disasters (C in figure 1.3) while the implications of complex political emergencies on logistics and supply chain management have not been analysed systematically.

Generally, a striking gap can be noted between academic literature, which rarely considers supply chain management of humanitarian assistance goods and humanitarian organizations, which rarely consider commercial supply chain management concepts which are well established in academic literature.

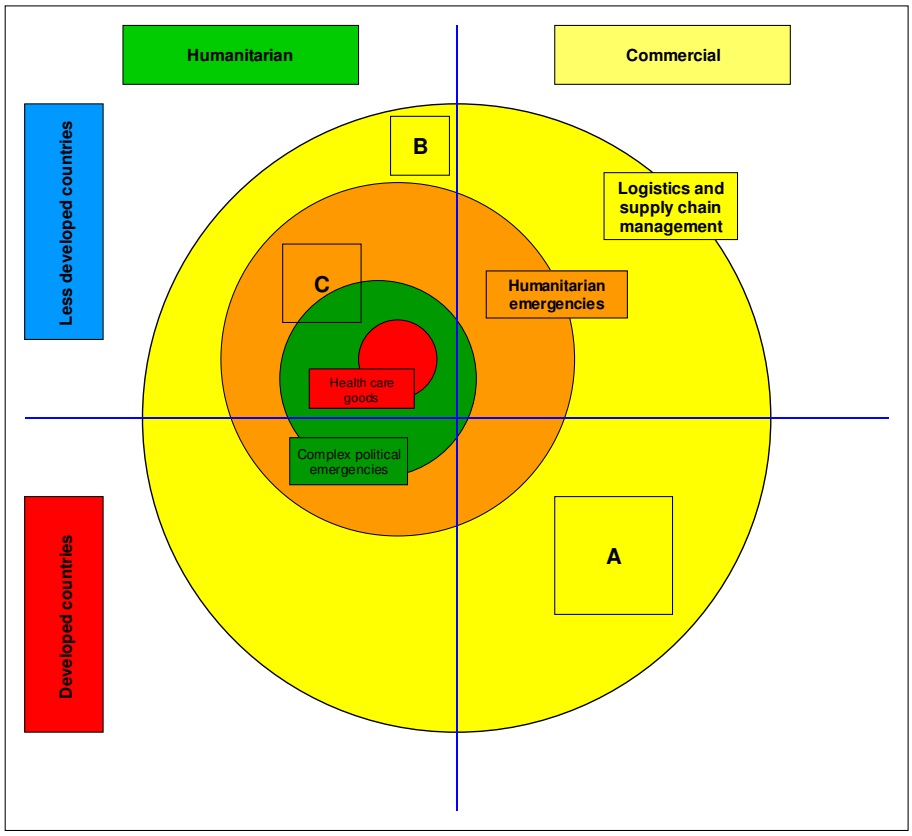

Figure 1.3 Fields of logistics and supply chain management literature

1.5 Research problems

The central research problem is the lack of a coherent and comprehensive supply chain management strategy for humanitarian assistance in general and for health care goods in particular. Although the claim has been made that logistics is becoming a "humanitarian science" (Loane, G. 1998, 5), humanitarian organizations have not realized the potential of systematically applying and adapting commercial supply chain management concepts to the very special context of humanitarian assistance.

The lack of such a strategy leads to ineffective and inefficient logistics management, funds and resources are poorly utilized and humanitarian assistance to people in need is reduced or delayed (Thomas, A. and L.R. Kopczak 2005, 2).

The lack of adequate quality assurance measures as well as deterioration during transport and storage can lead to the provision of low quality health care goods which reduces the quality of treatment and may even harm patients. As a consequence of shortages and stockouts of health care goods patients might not be adequately immunized, diagnosed, treated or operated on.

Ultimately poor logistics services and support reduce the quality of health services humanitarian organizations can provide and lead to preventable increases in suffering, morbidity, disability and mortality of populations affected by complex political emergencies.

1.6 Research questions and objectives

Figure 1.4 presents on overview of research problems, questions and objectives.

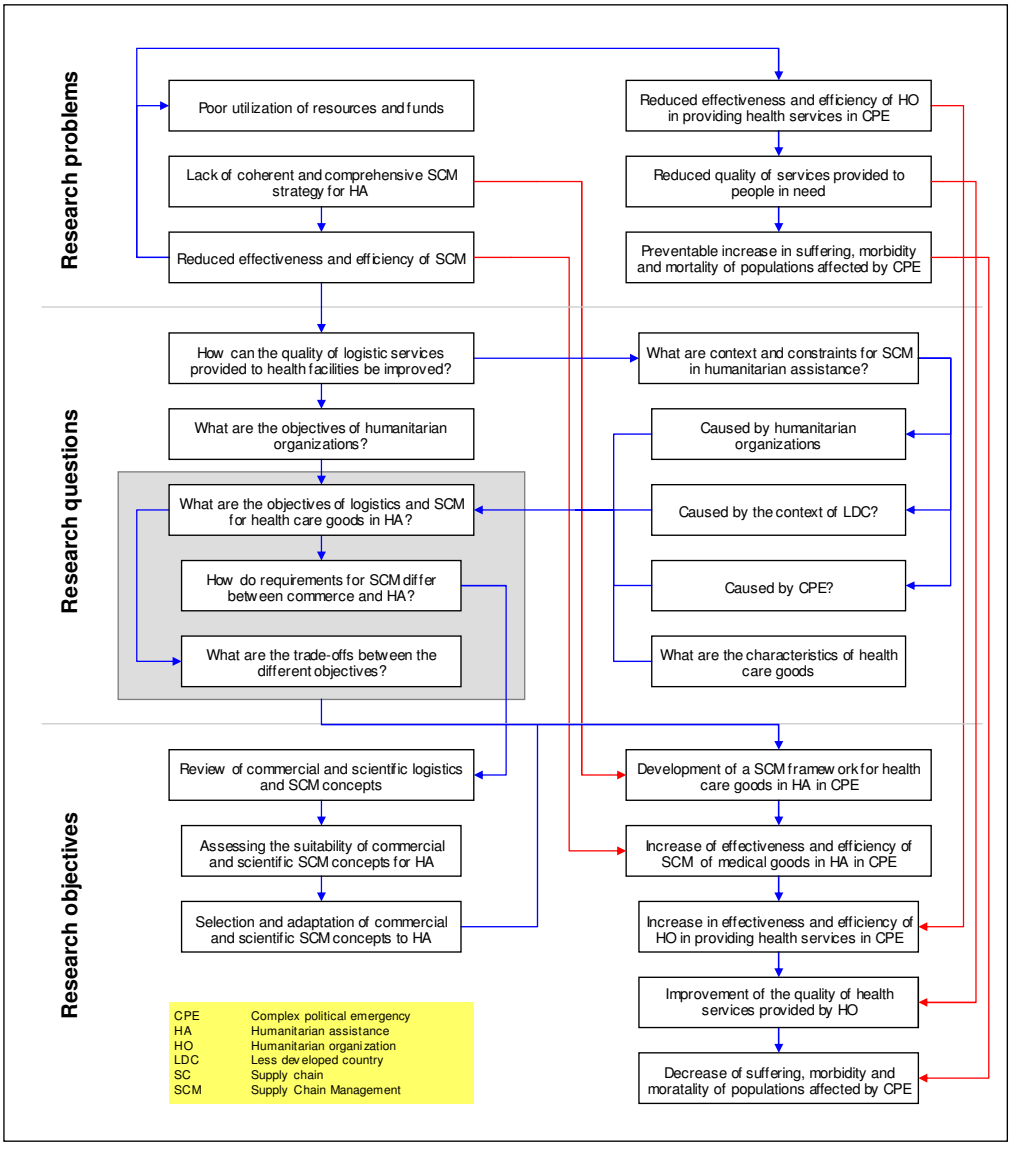

Figure 1.4 Research problems, questions and objectives

The research problems lead to the main question the research attempts to answer:

How should humanitarian organizations manage their supply chain for health care goods in order to improve the quality of logistics services provided to humanitarian assistance programmes in complex political emergencies?

The analysis of the objectives of humanitarian organizations as well as the context of and constraints caused by humanitarian organizations, less developed countries and complex political emergencies will allow answering the question of the logistics and supply chain management objectives in humanitarian assistance. Besides the characteristics of health care goods need to be considered.

Further research questions are the trade-offs between the found objectives as well as differences between commercial and humanitarian logistics and supply chain management.

One objective of the research is to review commercial and scientific logistics and supply chain management concepts, assess their suitability and apply and, where necessary, adapt them to the context of humanitarian assistance.

The final objective is the development of a supply chain management framework which will allow humanitarian organizations to achieve their objective of effectively and efficiently reducing suffering, morbidity, disability and mortality of populations affected by complex political emergencies.

1.7 Research methodology

Although, unlike in many other sciences, no generally accepted, coherent and comprehensive theory of logistics and supply chain management has been developed, a range of methods, concepts, models and frameworks have been proposed and are widely accepted.

This research does not intend to develop new methods or models but rather to apply and, where necessary, modify and adapt existing scientific methods and models to the context and constraints of humanitarian assistance. Therefore mainly a theoretical deductive method will be used.

The requisites of existing methods, models and frameworks developed for commercial logistics and supply chain management will be analysed and compared to the requisites, context and constraints of humanitarian assistance. While logistics management differs from industry to industry, most problems are comparable and similar principles and methods can be used for problem solving (Gudehus, T. 1999, 3).

These requisites will be derived from literature on logistics and supply chain management as well as on humanitarian assistance.

Where requisites are comparable, the most suitable methods, models and frameworks can be selected and applied to the context of this research. Where requisites differ, reasoning and simple heuristics will be used to modify and adapt methods, models and frameworks to the situation and needs of humanitarian assistance.

Applied research will be used since the topic is derived from a practical problem and the research aims at developing a practical solution, although founded on theory.

The research methodology will mainly be qualitative and use a phenomenological approach. Quantitative research would require large amounts of accurate data. Many humanitarian organizations do not have integrated information systems and often process data manually. Consequently data collection would require a disproportionate

amount of time. In order to yield valid results, data from several humanitarian organizations and several complex political emergencies would have to be collected and analysed. This would be associated with significant security risks and difficulties of gaining access.

Moreover developing a quantitative model would require the collection and analysis of data from all areas of logistics and supply chain management and exceed the scope of a single research project.

The central objective of this research is to develop a framework rather than an exact model. Using a framework as a method allows to reduce the complexity as well as to yield results which can be generalized in the context of this research.

The research objective is to develop a solution for a practical problem, not to analyse how or how well humanitarian organizations are managing their supply chain. Another reason for a qualitative approach is that in commercial logistics and supply chain management most factors can be evaluated in and reduced to financial terms. However, in the context of humanitarian assistance the main factors such as reduction of suffering or morbidity or the level of security cannot be measured and quantified financially or otherwise which developing accurate quantitative models would require.

Finally, the objective of this research is not to determine the best solution for a problem but rather to develop a framework which is suitable for the general context which humanitarian organizations face in complex political emergencies and which can be adapted, modified and optimized in a given situation by a given humanitarian organization. Since so far no comprehensive framework for this kind of context has been developed it seems justified to develop a qualitative framework rather than an exact quantitative model as a first step which can be extended by future quantitative research.

1.8 Theoretical approach

As a starting point and theoretical background, the research will be placed in the comprehensive hierarchical planning framework by Thorn (2002, 22).

The first dimension distinguishes between strategic, tactical and operational supply chain planning with decreasing lengths of their planning horizons and the second between sourcing, production, distribution and sales (figure 1.5).

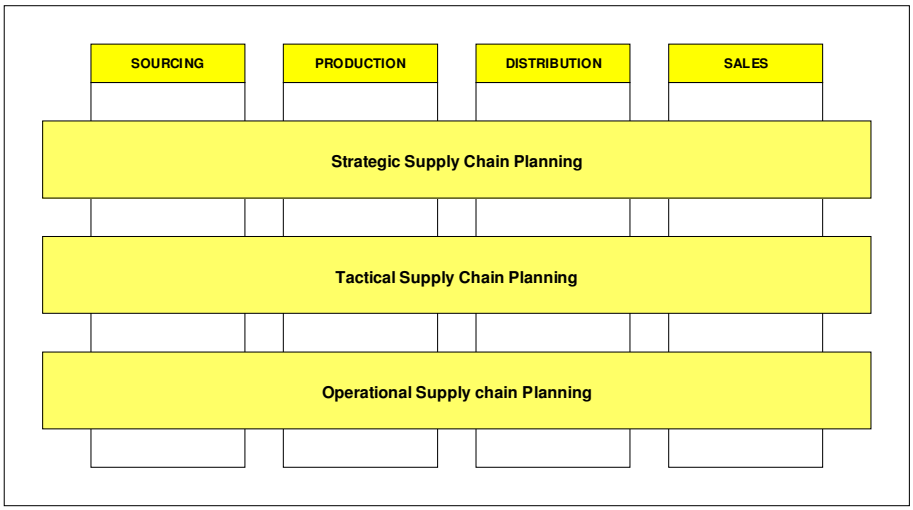

Figure 1.5 Thorn's planning framework

The strategic aspect of the framework concerns mainly the concept of supply network design which includes sourcing and determining optimal locations for distribution facilities. Tactical supply chain planning deals with determining optimum order quantities, stock levels within the distribution network as well as transport between its nodes. Finally operational supply chain planning attempts to optimize resources within the strategic and tactical supply chain planning framework, for example by maximizing transport efficiency.

Simchi-Levi and Kaminsky (2004, 13) use the same three levels for decision making. The strategic network design allows determining the optimal sourcing strategy, number, location and capacities of warehouses and/or plants as well as distribution channels. The main objective of this first level is to minimize total costs. The tactical level is concerned with coordinating production, distribution strategies and storage requirements to minimize system-wide costs and maximize profits. At the operational level, the framework focuses on day-to-day decisions of scheduling and routing.

The second dimension distinguishes between sourcing, production, distribution and sales. This is similar to the three supply chain macro processes of supplier relationship management, internal supply chain management and customer relationship management (Chopra, S., and P. Meindl 2004, 17).

1.9 Research design

The research starts by selecting the general research topic, reviewing literature pertaining to the research topic and determining the state of the field. This review considers scientific literature on logistics and supply chain management as well as publications by humanitarian organizations either related to logistics management or general aspects of humanitarian assistance which have implications for logistics and supply chain management. An overview of the research design is presented in figure 1.6.

The practical problem of a lack of a coherent and comprehensive supply chain management strategy for humanitarian assistance together with the review of the state of the field leads to formulating detailed research problems and develop research questions and objectives.

The following literature review on complex political emergencies as well as on less developed countries, will allow analysing the context in which humanitarian assistance programmes are set and point to constraints which humanitarian organizations face. Moreover the implications of the characteristics of health care goods on logistics and supply chain management will be determined.

Together with a further analysis of the objectives as well as the context and constraints of humanitarian assistance, the general logistics and supply chain management objectives can be derived.

Scientific supply chain management concepts, methods and models will be reviewed, discussed and applied to each of the logistics activities and management levels of Thorn's modified framework. Throughout the analysis the context and objectives of commerce and humanitarian assistance will be compared in order to determine differences and draw conclusions on differences for their respective logistics and supply chain management. This analysis will allow developing and building a framework which fulfills the general logistics and supply chain management requirements objectives determined earlier.

The research will be completed by summarizing the results, pointing out limitations and constraints as well as presenting a critique and an outlook for future research.

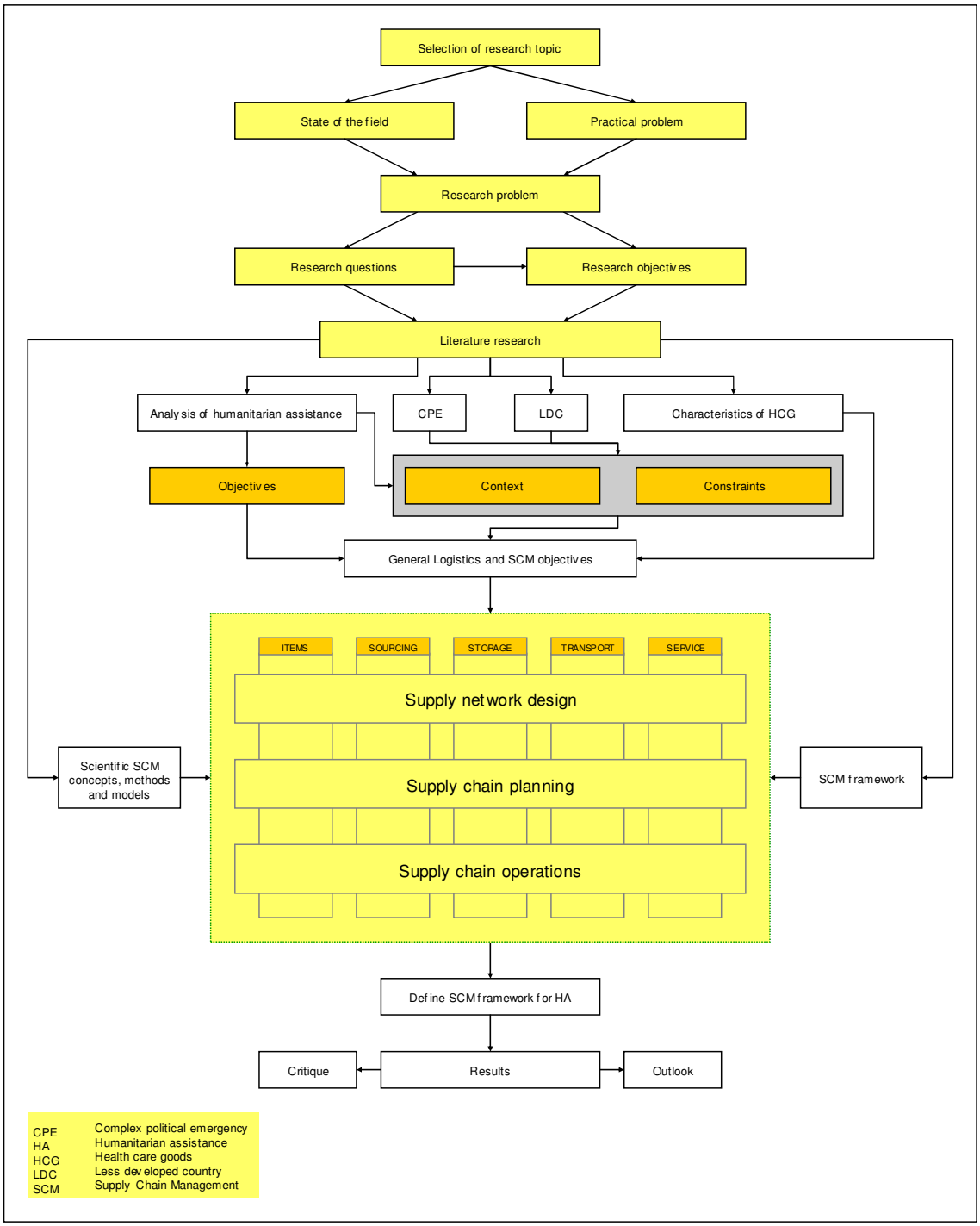

Figure 1.6 Research design

2 HUMANITARIAN ASSISTANCE

The following chapter introduces humanitarian assistance and analyses the objectives, context and constraints of humanitarian organizations as well as the characteristics of health care goods.

2.1 Introduction

Since the end of the Second World War on average 57 medium or high intensity conflicts were raging (HIIK 2005, 1) with civil wars typically lasting seven years on average (Collier, P. et al. 2003, 14), six times longer than interstate wars (Collier, P., A. Hoeffler, and M. Söderbom 2003, 2).

Figure 2.1 gives an overview of the development of the total number of medium and high intensity conflicts since the end of the Second World War.

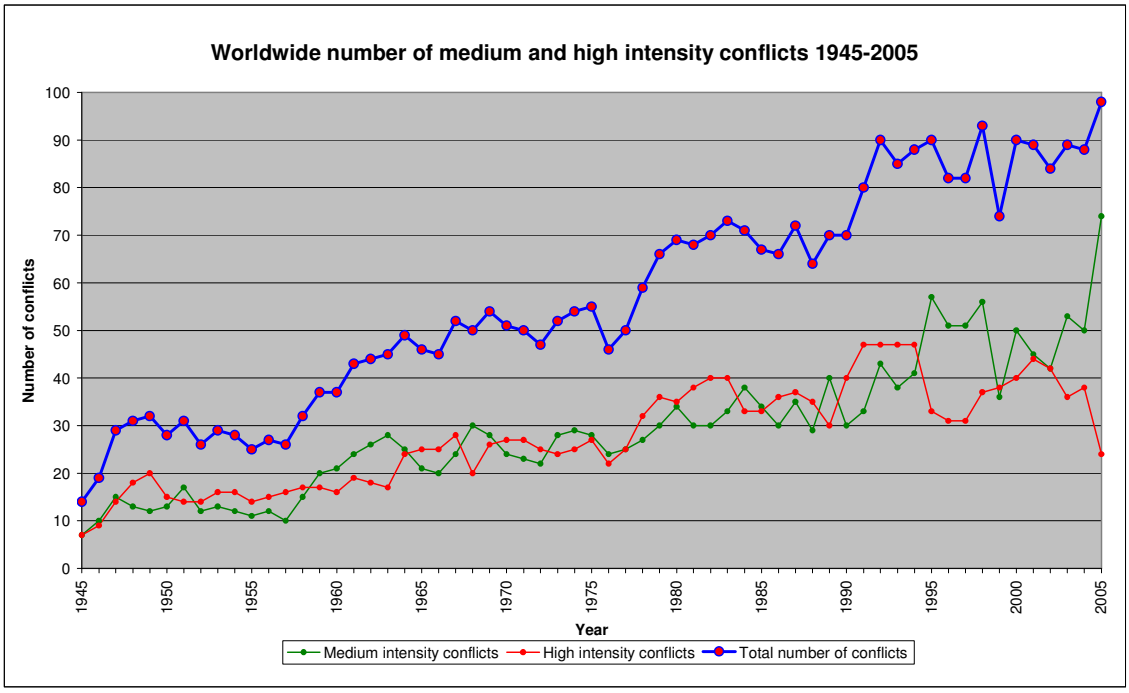

Figure 2.1 Worldwide number of conflicts 1945-2005 (HIIK 2005, 1).

The origins of humanitarian assistance can be traced back to the charitable orders in the middle ages (Macalister-Smith, P. 1985, 9) who cared for the wounded and sick. In the 18th century England provided bilateral assistance to Lisbon after the city was devastated by an earthquake.

The Battle of Solférino (Italy) in 1859 prompted the establishment of voluntary organizations for assisting wounded combatants as well as development of international humanitarian law and led to the founding of the Red Cross movement (Grossrieder, P. 2002, 26). Activities were later extended to the provision of humanitarian assistance goods which required transport and establishing warehouses.

Due to the collapse of industry, disruption of agricultural production, requisitioning as well as the blockade of ports, nine million people in France and Belgium were threatened by famine during the First World War. Over a period of five years, the

neutral Commission for Relief sustained a whole population by operating an entire fleet of ocean vessels and purchasing, shipping and distributing five million tonnes of humanitarian assistance goods (Macalister-Smith, P. 1985, 11).

In the aftermath of the First World War individual states were overwhelmed with millions of refugees in Europe, notably from Russia, and the League of Nations appointed a High Commissioner for Refugees, which among other tasks, provided material assistance. The recognition of the need for states to collaborate in providing and coordinating assistance to people affected by natural disasters prompted 30 states to establish the International Relief Union (IRU).

During the Second World War 40 governments founded the United Nations Relief and Rehabilitation Administration (UNRRA) which marks the beginning of international cooperation in humanitarian assistance. UNRRA was active in more than 20 countries, distributed more than 9 million tons of food over a period of five years and was important in provided material assistance to the over 20 million refugees in Europe after the Second World War.

The Red Cross Movement also played a key role in assistance operations after the Second World War and remained the principal humanitarian actor until the 1960s (European Commission 1998a, 4).

The realization of the limited effectiveness of an ad hoc response to natural disasters as well as of the need for emergency preparedness led to the establishment of the Office of the United Nations Disaster Relief Coordinator in 1971.

The crisis in Biafra (Nigeria) from 1967-1970 was a landmark in the development of humanitarian assistance and led to the founding of Médecins sans Frontières in 1968 (Grossrieder, P. 2002, 29).

During the last two decades the industry has grown significantly and today humanitarian organizations can be divided into governmental, inter-governmental, international non-governmental and international organizations (European Commission 1998b, 36).

The United Nations High Commission for Refugees (UNHCR) has a specific mandate to care for refugees and internally displaced persons (IDPs). UNHCR offers protection and assistance to displaced persons in an impartial manner, on the basis of their needs and irrespective of their race, religion, political opinion or gender. The UNHCR pays particular attention to the needs of children and seeks to promote equal rights of women and girls. It sets up refugee camps for tens or even hundreds of thousands of people and provides them with shelter, water and sanitation, food and health care. Wherever possible UNHCR will attempt to care for refugees and displaced populations by supporting them in their community rather than in camps.

The World Food Programme (WFP) was founded in 1963 to eradicate world hunger, is the world's largest international food aid organization and is active in disaster preparedness, prevention of famines, response to nutritional emergencies, rehabilitation programmes as well as in development work. This United Nations agency has established a sub-unit within its logistics service called ALITE (Augmented Logistics Intervention Team for Emergencies) which coordinates all available civil as well as military resources and logistics capacities in an attempt to enhance the organizations logistics emergency response and preparedness capacities.

The United Nations Children's Fund (UNICEF), founded in 1946, seeks to improve the lives of children in general by reducing hunger, disease, poverty and illiteracy as well as advocating children's rights, is a major partner in the Expanded Programme on

Immunization (EPI) and assists children and their mothers in natural and man-made disasters.

The World Health Organization (WHO) is mandated by its constitution, among others, to coordinate emergency assistance as well as to provide technical assistance and advice in the field of health (World Health Organization 1996, 12).

Médecins Sans Frontières (MsF) offers assistance to populations in distress, to victims of natural or man-made disasters as well as to victims of armed conflict. Unlike many other non-governmental organizations, it actively advocates and speaks out in favour of human rights of the people they care for.

Oxford famine relief (OXFAM) is primarily a development agency specializing on small scale community development programmes as well as advocating fair trade and respect for human rights. However the organization also intervenes in complex political emergencies and has gained a reputation for their expertise in providing clean water and sanitation services.

The work of the International Committee of the Red Cross (ICRC), an international organization, is based on the Geneva Conventions which are an important part of International Humanitarian Law (IHL). The ICRC looks after detainees and provides health care services and material assistance to people affected by armed conflicts.

2.2 Objectives

Commercial and non-profit organizations have much in common, among others their orientation towards serving customers (Badelt (ed.) 2002, 97), but also show important differences. While commercial organizations are motivated mainly by financial profits, non-profit organizations have mainly social objectives (Badelt (ed.) 2002, 136).

Although compliance with the "humanitarian imperative" is categorical (Slim, H. 2002, 6) and concern for people in need is the primary objective of humanitarian organizations, other stakeholders (Badelt (ed.) 2002, 218) as well as a multitude of other objectives (figure 2.2) must also be considered. The following chapter will discuss objectives humanitarian organizations have towards donors and the public, towards recipients as well as their own management objectives.

Even though each humanitarian organization has its own focus and develops its own objectives (Oloruntoba, R., and R. Gray 2003, 6), some objectives are common to most humanitarian organizations.

The analysis below does not claim to be complete but rather indicates issues which have important implications for logistics and supply chain management.

2.2.1 Objectives towards donors and the public

Since humanitarian organizations do not generate any income through their own activities and depend entirely on outside funding, they must consider the interests, requirements and conditions of donors. Furthermore the number of humanitarian organizations competing for limited donor funding is increasing (Thomas, A., and L.R. Kopczak 2005, 2).

Members of the public may fund humanitarian organizations directly through individual contributions or indirectly through tax money which is allocated by governments or government agency. In both cases public opinion is an important consideration as it may affect individual donations directly or may influence the goodwill of governments or government agencies. Moreover public opinion will have an

influence on the overall funding governments are willing to allocate to humanitarian assistance in general (European Commission 1998d, 98).

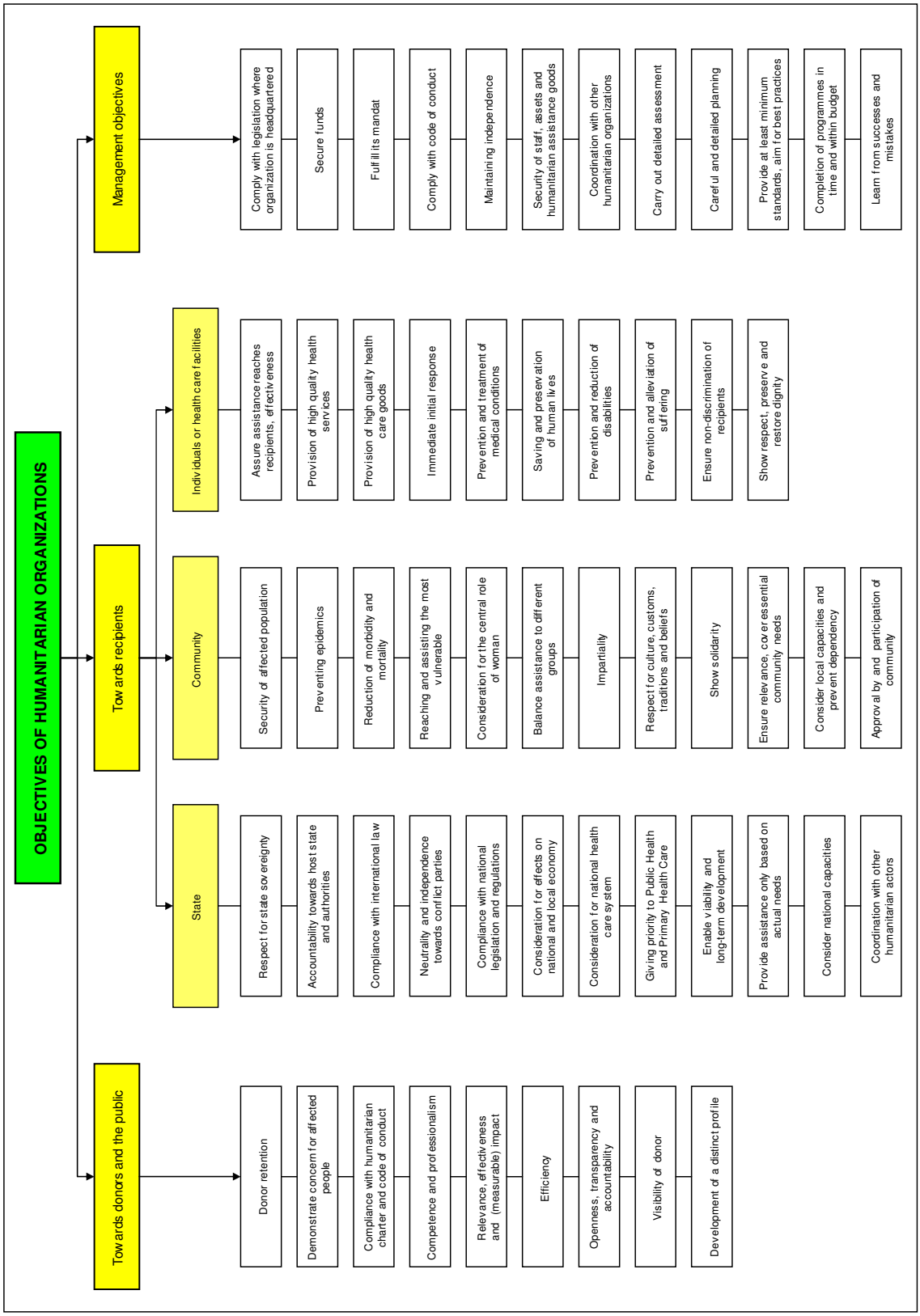

Figure 2.2 Objectives of humanitarian organizations

Since demand for humanitarian assistance always exceed supply, humanitarian organizations do not need to market their services towards recipients. However they need to retain donors by marketing the services they provide to people in need (Oloruntoba, R., and R. Gray 2003, 9).

In order to be credible, humanitarian organizations will have to demonstrate their genuine concern for the plight of people affected by humanitarian emergencies as well as their respect for recipients. They will portray themselves as being motivated mainly by humanitarianism rather than their own interests.

Although not legally binding, many humanitarian organizations have voluntarily committed themselves to minimum standards of humanitarian assistance as defined by the Humanitarian Charter (The Sphere Project 2004). Signing of varies charters may be a precondition for becoming eligible for funding (Harris-Curtis, E. 2001, 4).

There is general agreement among donors as well as humanitarian organizations that humanitarian assistance must be planned, organized and implemented in a professional manner (European Commission 1998c, III).

Humanitarian organizations applying for funding by the European Community Humanitarian Office (ECHO) must demonstrate, among others, their administrative, financial, technical and logistical capacity as well as experience in the field of humanitarian assistance (EC 1257/96, Art. 7.2).

In order to become and remain competitive in obtaining funds, humanitarian organizations need to convince donors of their competence and professionalism.

Humanitarian organizations need to demonstrate the relevance as well as the effectiveness of their interventions (ECHO 1999, 20). Reporting in terms of outputs (Slim, H. 2002a) such as quantities of distributed health care goods is no longer sufficient. Increasingly donors are carrying out evaluations and require humanitarian organizations to demonstrate their contribution to reducing suffering as well as a measurable impact of their interventions such as the reduction of morbidity and mortality (ECHO 1999, 35).

Among different alternatives for achieving stated objectives, humanitarian organizations must chose the option requiring the least resources and demonstrate the efficiency of their logistics management (ECHO 1999, 35).

Since assessing the costs of different options of entire humanitarian assistance programmes is difficult, donors may instead analyse individual components such as transport and distribution costs (ECHO 1999, 52).

Although so far no legal framework for the work of humanitarian organizations has been established (OECD 1999, 19), transparency and accountability towards donors is an indispensable prerequisite for obtaining funds for future humanitarian assistance programmes. Donors will usually grant funds under the condition of receiving detailed reports from humanitarian organizations on their achievements and utilization of funds (ECHO 2003, 2). In addition donors may make funding conditional upon the right to conduct audits at headquarters or in the field and have access to all relevant records at any time without prior notice (ECHO 1999, 71). The signatories of the Code of Conduct hold themselves accountable to donors as well as recipients of humanitarian assistance (The Sphere Project 2004, 320).

In order to demonstrate openness in general as well as to account to individual donors who cannot perform audits, humanitarian organizations need to regularly publish reports on their activities and usually publish an overview of their annual accounting.

One of the conditions for granting funds to humanitarian organizations may be the visibility of donors towards recipients and local authorities by printing logos on distributed assistance goods or displaying signs on offices, vehicles or stores (ECHO 1999, 57) as well as mentioning donors in public communications such as press releases and reports.

Some humanitarian organizations develop a distinct identity and public image for example by emphasizing their capacity, efficiency, speed, competence, flexibility or advocacy of human rights.

2.2.2 Objectives towards recipients

Humanitarian organizations need to consider their objectives towards the state, the community as well as individual recipients which benefit from or host humanitarian assistance programmes.

The respect for state sovereignty is a central principle of humanitarian assistance and states have a primary role in the initiation, organization, co-ordination and implementation of humanitarian assistance within their territories (UN General Assembly Resolution 43/131, 1988).

Consequently humanitarian organizations must seek approval from the state, the respective authorities or parties in control of the territory for which humanitarian assistance is intended (Stoffels, R.A. 2004, 534) and are accountable towards the host state and authorities for their activities.

States may decide to rely on their own means for providing assistance to the affected population (European Commission 1998c, 11) or impose restrictions on the implementation of humanitarian assistance programmes.

Humanitarian assistance programmes must meet any applicable provisions of international law (European Commission 1998c, 3) such as the right of the state to control immigration (European Commission 1998c, 12).

International organizations may be held accountable for any violations and even be liable to compensate the state (European Commission 1998c, 14).

According to the United Nations humanitarian, assistance must also be provided in accordance with the principle of neutrality (UN General Assembly Resolution 43/131, 1988), which means that humanitarian organization must not favour any party to the conflict and must not in any way participate in hostilities.

Increasingly humanitarian assistance is becoming part of political and military intervention strategies of donors and states (VENRO 2003, 2). Humanitarian organizations must remain neutral, refrain from favouring any party to the conflict and maintain their independence from political, economic, military or other objectives of any of the actors in the conflict (ECHO 2003, 9). Humanitarian assistance must also not be used as a substitute for political action (ECHO 1999, 78) or for furthering political objectives (The Sphere Project 240, 318).

Humanitarian organizations must also comply with national legislation and regulations (European Commission 1998c, 3), respect immigration laws, obtain residence and work permits (European Commission 1998d, 97). Humanitarian workers must have the required professional qualifications required for practicing in the host country, for example as a health professional. Labour and social security laws must be complied with when employing national staff (Mayhew, B. 2004, 15). Foreign driving licences require approval and vehicles must comply with highway codes and be registered. Operation of aircraft in the host country must consider national legislation

and regulations on registration of aircraft, obtaining flight clearances or licensing of pilots. Importation, installation and operation of telecommunications equipment are often subject to strict laws and regulations. Some countries are very restrictive in granting operating licences and assigning appropriate radio frequencies (Klenk, J.S. 1997, 42). The Tampere Convention (1998) seeks to facilitate the use of telecommunications equipment in emergencies by removing regulatory barriers and waiving fees. However the convention is limited to disasters and has so far only been ratified by 30 states.

Drug products and other health care goods must be imported according to the provisions of the respective national drug acts (WHO 1996a, 186) and national pharmaceutical legislation must also be considered for their storage and distribution. In particular regulations concerning narcotic drugs and psychotropic substances which are subject to international control must be adhered to (WHO 1996a, 192).

Trade laws apply in general whenever humanitarian organizations buy goods in the host country, customs laws apply for importation of goods and humanitarian organizations must respect tax and fiscal laws.

All employees of humanitarian organizations have to comply with the respective national civil law as well as provisions of the penal code.

In order to avoid creating shortages with subsequent price increases or a surplus of goods which decreases prices, humanitarian organizations must consider the consequences on the domestic as well as the local economy and avoid any adverse affects on the domestic market (Ockwell, R. A. 1994, 149).

Humanitarian organizations must consider existing national health care systems and possible undesirable consequences of their own programmes. For example providing health services free of charge can damage well established cost recovery systems and may reduce local prices health professionals can charge patients. Introducing drug products, strengths or dosage forms which are not commonly used may undermine standard treatment protocols as well as the use of national essential drug lists.

Provision of free hospital care may disrupt the referral system and cause hospitals to become overwhelmed with patients although the majority of patients could be treated at lower levels of the health care systems more economically.

A well established distribution network for regularly supplying health care facilities may be disrupted by direct deliveries from humanitarian organizations, especially after assistance is withdrawn.

Humanitarian assistance should be based on primary health care principles (The Sphere Project 2004, 264) and give priority to public health which will ensure that the greatest health benefit is provided to the greatest number of people (The Sphere Project 2004, 259). This implies decentralization of health services in order to give a maximum number of people access (Perrin, P. 1996, 195) as well as to avoid a small number of central health care facilities being overwhelmed with patients (Perrin, P. 1996, 196).

Humanitarian organizations must integrate their assistance into existing health care systems and consider the long-term viability and sustainability after their assistance ends (The Sphere Project 2004, 29). Humanitarian organizations should, wherever possible, reinforce existing structures and processes rather than create new ones (Ockwell, R. A. 1994, 22). Humanitarian assistance programmes should consider the link between relief, rehabilitation and development and, wherever possible, consider long-term development objectives (ECHO 2003, 9).

The second principle of the Code of Conduct states that, wherever possible, humanitarian organizations will carry out thorough assessments (The Sphere Project 2004, 317) and provide humanitarian assistance according to established needs of affected populations.

Signatories also commit themselves to consider local capacities and to strengthen these capacities by employing local staff and purchasing goods locally (The Sphere Project 2004, 319).

According to the Madrid Declaration providers of humanitarian assistance as well as donors will ensure close coordination in order to achieve maximum impact in reducing suffering (ECHO 1999, 77). Moreover donors are encouraging collaboration among humanitarian organizations in order to avoid expensive duplications (Thomas, A., and L.R. Kopczak 2005, 2).

At the next level humanitarian organizations have to consider their objectives towards the communities receiving humanitarian assistance.

Humanitarian organizations must above all consider the security of assisted populations and attempt to minimize any adverse effects humanitarian assistance programmes could have (The Sphere Project 2004, 18). As far as possible, humanitarian assistance must not be provided in insecure places or areas and must not endanger people who try to reach health services.

Although the notion that disasters itself or human remains inevitably cause epidemics is a myth (PAHO 2004, 71), high population densities and poor sanitary conditions together with the deterioration of health services are highly conducive to an increased incidence of communicable diseases. The prevention of epidemics, especially of measles, must be one of the priorities for humanitarian organizations since they may be the leading cause of mortality even during armed conflict (Guha-Sapir, D., and W. van Panhuis 2002, 19).

One of the primary objectives of humanitarian assistance and of providing health services in particular is the reduction of excess morbidity and mortality (Checchi, F., and L. Roberts 2005, 1). Excess morbidity and mortality is calculated by comparing morbidity and mortality before and after the onset of complex political emergencies.

Following a careful assessment of needs, humanitarian assistance must selectively be provided to the most vulnerable recipients, such as children, woman and the elderly, first (Russbach, R., and D. Fink 1994, 6). The importance of women participating in all stages of humanitarian assistance programmes is generally acknowledged (ECHO 1999, 80).

At the same time humanitarian organizations must balance their assistance to different groups and avoid causing resentment, by providing a higher level of services to certain groups, such as displaced people, than to the host community (Perrin, P. 1996, 318).

Humanitarian assistance must respond only to needs and interests of people in need, must be provided in an impartial manner, regardless of age, gender, birth, race, ethnicity, religion, creed, political affiliation or nationality of recipients and without adverse distinction of any kind (ECHO 1999, 64).

Humanitarian workers must also respect national and local culture, customs, traditions and religious beliefs (The Sphere Project 2004, 318). Humanitarian assistance should be motivated by a feeling of solidarity (Russbach, R., and D. Fink 1994, 6) and is also a way of the international community to express solidarity with the suffering population (Oxfam 2000, 10).

Since needs may vary between different communities and different health care facilities, humanitarian assistance must be based on individual assessments, be relevant and cover essential needs (Perrin, P. 1996, 409).

Humanitarian assistance programmes must complement and build on local resources and capacities, by employing local staff and supporting local trade (The Sphere Project 2004, 319) and must be coordinated with local authorities. Local health services should be strengthened rather than establishing alternate or parallel health care facilities or services, unless local capacities are exhausted (The Sphere Project 2004, 262). Replacing local services should only be considered as a last resort after all other options have been explored (Perrin, P. 1996, 323).

Even in emergencies humanitarian organizations should assist communities in regaining self-sufficiency and avoid creating dependencies (ECHO 1999, 12).

Communities and local authorities must be consulted, participate in the assessment and programme design and approve implementation of humanitarian assistance programmes (The Sphere Project 2004, 319).

Finally objectives towards the recipients, which may be individuals, health professionals or health care facilities, need to be considered.

Above all humanitarian organizations must ensure that assistance is effective and goods and services actually reach recipients. The effectiveness of certain health interventions such as mass immunization or antenatal care depends on a high coverage (Simmonds, St., P. Vaughan, and S.W. Gunn (ed.) 1986, 37).

One of the main objectives of the Sphere Project is to enhance the effectiveness and quality of humanitarian assistance (The Sphere Project 2004, 14) which in turn requires, among others, providing high quality health care goods.

Humanitarian organizations applying for funding through ECHO must commit themselves to implementing humanitarian assistance programmes in accordance with best practices and based on the concept of quality of assistance (ECHO 2003, 9). The quality of provided goods and services is also a criterion for the evaluation of humanitarian assistance programmes which receive funds (ECHO 1999, 35).

At the outset of humanitarian emergencies, humanitarian assistance must be provided as quickly as possible (Perrin, P. 1996, 16). Once humanitarian assistance programmes and their supporting supply chain are established, uninterrupted availability of health care goods may be assured in other ways such as planning ahead or establishing stocks.

Health care interventions attempt to prevent or at least control outbreaks of diseases and epidemics (The Sphere Project 2004, 279), especially measles, and to ensure treatment of injured and sick people. According to the Sphere Project the effectiveness of health care programmes can be objectively determined by monitoring death rates and their decrease.

Ultimately the main purpose of humanitarian assistance programmes is saving and preserving human lives (EC 1257/96, Art. 2). Once survival is ensured preventing or at least reducing disabilities, for example by saving organs or limbs, as well as rehabilitation measures are also important concerns.

The "humanitarian imperative" (The Sphere Project 2004, 16) states that all possible steps should be taken to prevent and alleviate human suffering.

Within communities all individuals must be treated as equals and humanitarian assistance must be provided depending on needs alone and without any kind of discrimination (European Commission 1998a, 5).

The right to life with dignity (The Sphere Project 2004, 17) is one of the two core principles of the Humanitarian Charter. Recipients must be treated with respect and in their communications humanitarian organizations should not present recipients as "objects of pity" (ECHO 2003, 3).

2.2.3 Management objectives

Like any other organization, humanitarian organizations must chose a legal form of corporation and comply with national legislation and regulations in the country of their head office, for example concerning registration and licensing, employment of staff, taxation or exportation of goods.

Since humanitarian organizations do not generate any income through their activities they must first of all secure and maintain sufficient funding for maintaining their organization as well as for implementing humanitarian assistance programmes (European Commission 1998d, 46). At the same time humanitarian organizations will want to avoid becoming dependent on the means and goodwill of a single donor (The Sphere Project 2004, 318).

Humanitarian organizations will strive to fulfill the mandate they have chosen or they have been assigned. They will also have to focus on their core competencies (European Commission 1998d, 27) since no humanitarian organization has the capacity, expertise or funding to provide comprehensive assistance to all people in need. Such a focus may be on certain groups of people in need such as children or refugees, certain services such as food aid or health services, certain countries or regions or certain situations such as emergency assistance or long-term development (Oloruntoba, R., and R. Gray 2003, 6).

So far the industry of humanitarian assistance is poorly regulated, with the exception of international organizations, humanitarian organizations are essentially self-mandating (Slim, H. 2002a) and, except towards their donors, humanitarian organizations have no formal responsibilities and are hardly accountable (Davis, A. 2001, 7).

Ethically humanitarian organizations are accountable to recipients but in practice the later have very limited possibilities of applying pressure or even sanctions. However a system of commitment to voluntary charters and codes of conduct has emerged (Leader, N. 2000, 3). Noteworthy initiatives are the Sphere Project, the Madrid Declaration (ECHO 1999, 77), the Humanitarian Accountability Project (Callamard, A. 2003, 35) as well as the Active Learning Network on Accountability and Performance (ALNAP). Adherence to codes of conduct (ECHO 2003, 2) may be a condition for becoming eligible for funding. The introduction of internationally recognized ISO 9001 certification for humanitarian assistance providers has also been proposed (Verboom, D.B. 2002, 38).

However voluntary codes are not legally binding and non-compliance has no immediate negative consequences. As an alternative a voluntary international accreditation system has also been recommended (Stockton, N. 2001, 15) where an independent body would monitor compliance with defined standards. Personal accreditation of humanitarian workers and establishing an international disaster response law with internationally agreed standards has also been suggested (Hilhorst, D. 2001, 22).

In order to carry out their mandate in an impartial and neutral way, humanitarian organizations must maintain their independence from any donors as well as economic, military and political actors (ECHO 2003, 9). The Sphere Project stresses the

importance of formulating and implementing strategies and assistance programmes without being influenced by political interests of donors or foreign policies of governments (The Sphere Project 2004, 318). Humanitarian organizations must also avoid being used to gather political, military or economic information for donors. Humanitarian assistance programmes must be driven by needs alone and humanitarian organizations must base decisions on programmes on a sound assessment of the situation alone.

While humanitarian organizations must focus on the needs of recipients in an increasingly violent environment, security and safety of staff must be their first priority. Humanitarian organizations are accountable for assistance goods as well as assets and must, as far as possible, prevent diversion, misuse, damage and destruction which not only leads to losses but also to withholding urgently needed goods and services from people in need.

According to article 71 of the First Protocol Additional to the Geneva Conventions, any personnel participating in the provision of humanitarian assistance must not be attacked and must be respected and protected. Medical stocks must never be prevented from operating, attacked, damaged or destroyed and any transport of medical consignments must be protected (ICRC 1999, 8). According to the Statute of the International Criminal Court direct, intentional attacks against humanitarian workers as well as equipment and infrastructure involved in humanitarian assistance constitute a war crime (Rome Statute Art. 8.2.b (iii)).

If humanitarian organizations above all strive to reduce suffering they must avoid wasting valuable resources (PAHO 2001, 21) and closely coordinate their assistance programmes with other humanitarian actors. Moreover humanitarian organizations are likely to be denied any funding for providing goods and services which are already being provided by other humanitarian organizations since donors want to maximize the effectiveness of the resources they provide (Minear, 1999).

Finally the scope of many complex political emergencies clearly exceeds the capacity, resources and expertise of any single humanitarian organization. The increasing complexity of humanitarian assistance and developed technologies encourages specialization by humanitarian organizations on certain services. This in turn requires coordination and cooperation with other humanitarian organizations to provide people in need with the whole range of required goods and services.

Humanitarian organizations can also gain mutually by sharing information collected from assessments or sharing storage facilities and transport resources.

Every humanitarian assistance programme must be preceded by a thorough and detailed assessment of the context, situation and needs of the affected population (Russbach, R., and D. Fink 1994, 7). In parallel domestically and locally available logistics resources need to be assessed (PAHO 2001, 15).

Humanitarian assistance programmes must be carefully planned in order to be effective and make the best use of the limited resources humanitarian organizations have at their disposal (WHO 1996, 15).

Many leading humanitarian organizations have committed themselves to the Minimum Standards in humanitarian assistance (The Sphere Project 2004, 19). The "Humanitarian Charter and Minimum Standards in Disaster Response" defines quantifiable and measurable indicators for the areas of water supply and sanitation, nutrition, food aid, shelter and site planning as well as for health services which humanitarian organizations can monitor to determine the quality of their intervention.

The European Community goes further in requiring humanitarian organizations applying for funding to commit themselves to implement humanitarian operations in accordance with the best practices in the sector (ECHO 2003, 9). However these best practices are not specified any further.

As funds are limited and donors demand measurable results, humanitarian organizations must strive to complete humanitarian assistance programmes and achieve their objectives within the planned time frame and budget.

In order to improve their services, humanitarian organizations must monitor and regularly analyse their performance and learn from their past successes as well as mistakes and failures (European Commission 1998d, 47).

2.3 Context and constraints

The following chapter will describe the environment in and the circumstances under which humanitarian assistance programmes and their supporting logistics services are implemented. An overview of the context and constraints is given in figure 2.3.

Some constraints which restrict, confine, limit and sometimes impede operations, mainly inside the countries where humanitarian assistance is provided, will be pointed out.

2.3.1 Humanitarian organizations

By definition international humanitarian organizations do not strive for profits and financial considerations are not a priority in their overall strategy (European Commission 1998d, 40).

However Drucker claims that, although non-profit organizations do not have a "bottom line" they are nevertheless more money-conscious than commercial organizations (Drucker, P.E. 1989, 89).

Humanitarian organizations have no need to compete against each other for the markets and customers they are serving as demand for assistance to people is almost unlimited and by far outweighs supply.

Humanitarian assistance can be considered as "one of the largest unregulated industries in the world" (Buchanan-Smith, M. 2002, 40) which lacks common standards and mechanisms for evaluation (European Commission 1998d, 42). There are hardly restrictions on establishing humanitarian organizations and raising funds. Although training courses are offered by various organizations, so far humanitarian assistance is not an acknowledged profession which requires obtaining specific skills or knowledge for qualifying. The criteria for recruiting national and international staff are left to humanitarian organizations.

In many countries state authorities do not exist and recipients, who are usually dependent on humanitarian assistance they receive, can hardly sanction humanitarian organizations for providing poor or even inadequate services.

However since funds are in short supply, donors can exert significant pressure on humanitarian organizations by withholding funds or making funding conditional on compliance with defined criteria for the quality of provided humanitarian assistance.

Whereas commercial organizations are free to chose the markets where they want to offer goods and services, humanitarian organizations must remain impartial towards all conflict parties at all times (Russbach, R., and D. Fink 1994, 5). Consequently humanitarian organization may have to provide humanitarian assistance to populations

in the territory under control of other conflict parties even if the humanitarian needs of the affected population there are less urgent.

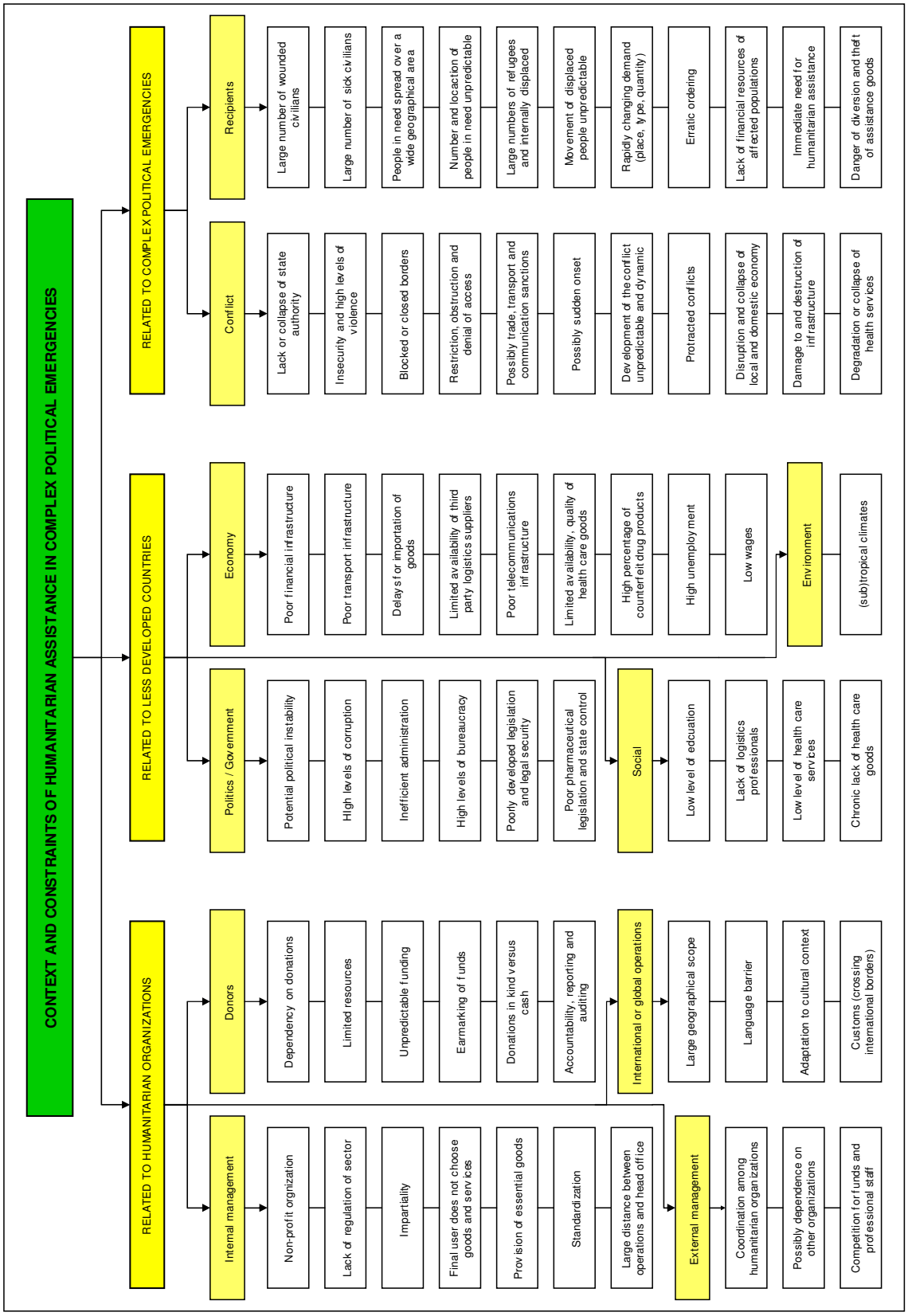

Figure 2.3 Context and constraints of humanitarian assistance

Recipients rarely have the opportunity to choose between different services or a certain service provided by different humanitarian organizations (European Commission 1998d, 39), such as free treatment at different health care facilities. Likewise health care facilities cannot choose the health care goods they receive. Recipients receive goods and services free of charge which are ultimately paid by the donors of humanitarian organizations and depend on the professionalism of the humanitarian organization to ensure that the most urgent needs are addressed.

Humanitarian organizations are in principle free to decide what kind of services they offer to people in need provided that their donors approve the respective humanitarian assistance programmes. Except in the rare situations where humanitarian organizations have funds at their disposal for which they are not accountable to anyone, ultimately donors decide on the kind of goods and services, the places where they are provided and the number of recipients. Donors will rely, at least to some degree, on the judgment of the humanitarian organizations since the later have more experience and a better insight into humanitarian situations. Donors may also agree to a certain amount of funding for assistance to health care facilities and defined places but leave the design of the humanitarian assistance programme entirely up to the humanitarian organization (European Commission 1998d, 13). Donors, which lack the expertise and organization for implementation, effectively outsource services, which they are unable to provide themselves, to specialized humanitarian organizations.

Since humanitarian organizations do not compete among each other for market share, want to cover essential needs and have only limited funds at their disposal, they will provide only a limited range of essential goods. The selection of individual goods is based on their suitability, quality and price and there is no purpose in providing a variety of goods, such as different sizes, designs or makes, provided they all serve the same purpose.

The standardization of assistance goods as well as equipment used for implementing humanitarian assistance programmes is a cornerstone of efficient logistics management (WHO 1992b, 13) and is a means of improving the quality of services (Perrin, P. 2002, 25). The idea dates back more than a century (Van Meerdervoort, P. 1885, 99) and is reflected in elaborate standard item catalogues. Standardization allows identifying the most suitable items (Lonergan, E. 2003, 90), ensuring compatibility among them, allows identifying potential suppliers in advance as well as limiting and minimizing the overall number of items logistics services need to provide. Since standardization allows reducing the number of different items, forecasting accuracy is increased through risk pooling (Simchi-Levi, D., Ph. Kaminsky, and E. Simchi-Levi 2003, 229).

For health care goods, standardization of items is also a consequence of using standard treatment protocols which allow health care workers with limited medical training to provide adequate treatment for the most common medical conditions (Antequera, M.G., and M.M. Suárez-Varela 1999, 608). The standardization of diagnostic and therapeutic procedures is of particular importance in the emergency phase of humanitarian assistance (Perrin, P. 1996, 205) where decisions need to be taken quickly and assistance must not be delayed by selection and sourcing of suitable items.

Determining the needs of assisted populations together with the standardization of health care goods allows to develop tailor-made formularies for assisted health care facilities such as clinics and hospitals which greatly facilitate the task of forecasting demand and greatly reduce the complexity of required logistics services in general (Health Action International 1998).

Head offices of international humanitarian organizations, often located in developed countries, and managers of humanitarian assistance programmes, usually working in less developed countries, are often separated by large physical and sometimes cultural distances (European Commission, 1998d, 40). Communications between programme managers in the field, often in remote areas with no telecommunications infrastructure, can be difficult and slow. Consequently even major decisions might have to be taken in the field quickly without the possibility of waiting for advice or approval by the head office. Conversely it may be impossible for head offices to inform or instruct managers in the field without some delay. At least for operational decisions, humanitarian organizations must therefore adopt a decentralized management structure (European Commission, 1998d, 41).

Most humanitarian organizations do not generate any income through their activities and therefore depend entirely on funds provided by private and institutional donors (European Commission 1998d, 58).

Although humanitarian organizations can plan ahead, implementation of humanitarian assistance programmes is always subject to obtaining sufficient funds on time. Donors may attach conditions such as utilizing funds for specific programmes, specific groups of recipients, using funds in a specific geographical area or country and spending the money by a certain deadline.

Since funds are scarce humanitarian organizations rarely have a choice between donors and can hardly afford to turn down an offer for funding because they do not agree with the donors' terms.

Dependency on donations therefore limits the flexibility of humanitarian organizations and can also delay their response to new crises which emerge suddenly.

Although humanitarian organizations compete for funds (European Commission 1998d, 97), major international humanitarian organizations often launch inter-agency consolidated appeals which allow coordination among the appealing humanitarian organizations, among donors as well as between these two parties.

Humanitarian organizations are constrained by their own capacity as well as by limited material and financial resources which are at their disposal (Forman, S., and A. Stoddard 2002). Consequently they have to limit the number of people they can assist as well as the scope and quality of services they can afford to provide. In order to maximize goods and services provided to recipients, resources must be utilized as efficiently as possible (WHO 1996, 3) and overheads must be kept as low as possible.

Funding of humanitarian assistance programmes is often inconsistent, unpredictable and erratic, some programmes are under-funded while others are over-funded (Van Brabant, K. 2002, 20). Donor decisions are at times determined by factors which are not directly related to the needs of affected people, such as political considerations, as well as outside the influence of humanitarian organizations.

Variations in government budgets for humanitarian assistance may not be related to changes in the needs of people affected by complex political emergencies (Oloruntoba, R., and R. Gray 2003, 6). Availability of private funds may correspond to ". . . fashion or to emotional, impulsive, or superficial responses" (European Commission 1998d, 40). The response may also depend on the geographical proximity between donors and people affected by complex political emergencies (Oxfam 2000, 6). The intensity of media coverage, which does not necessarily correspond to the extent of complex political emergencies and the needs of people (Russbach, R., and D. Fink 1994), can also influence donor behaviour. On the one hand humanitarian organizations may face severe shortages for "forgotten conflicts"

and on the other hand may have more funds at their disposal for certain humanitarian assistance programmes than required.

Donor decision may be based on short-term political considerations (Oloruntoba, R., and R. Gray 2003, 26) and the unpredictability of funding makes long- and even mid-term planning very difficult.

Another difficulty humanitarian organizations commonly face is the practice of "earmarking" funds (Forte, G.B. 1994, 6) where donors provide funds only for a specific programme and sometimes for a narrowly defined range of goods. The use of funds according to the terms prescribed by the donor may lead to a mismatch between offered and most urgently needed goods. Donors may be inclined to provide goods and services which receive more media coverage and which are perceived as priorities by donors (European Commission 1998d, 32).

Earmarking prevents humanitarian organizations from providing other goods or services to the affected populations or from using the funds to cover more urgent needs in other crises. The consequence is a high probability of inefficient allocation (European Commission 1998d, 31) where funds are not spent according to the priorities of recipients. Selling of food for cash by recipients, which allows people in need to purchase other urgently needed goods and services, is common.

Similar problems are caused by donations in "kind" rather than "cash". Donations of goods limit the flexibility of humanitarian organizations of responding to actual and most urgent needs. These donations may also incur significant transport costs and prevent purchase near to the affected area which allows reducing transport costs as well as response time. Donated goods may also be unsuitable for the context such as drug products suited for the epidemiology of developed countries rather than populations affected by complex political emergencies in less developed countries. More than half of all drug products donated to Bosnia and Herzegovina between 1992 and 1996 were inappropriate and 17,000 metric tonnes of unwanted drug products accumulated, which cost USD 34 million to dispose of properly (Berckmans, P. et al. 1997, 3).

Humanitarian organizations are accountable to their donors and must provide reports on the impact of their humanitarian assistance programmes as well as the use of funds. While donors can audit financial records and purchasing procedures, verifying the distribution of goods or the quality of services in the field is far more difficult (European Commission 1998d, 58). Only donors which have the necessary expertise, staff and means at their disposal can audit the implementation of humanitarian assistance programmes and obtain independent information from recipients. Other donors must rely on the trustworthiness of the humanitarian organization they are funding.

In complex political emergencies where the host government or authorities do not take charge, coordination among humanitarian organizations, which is necessary to maximize overall utilization of funds, can also impede and delay planning. As no formal coordination mechanisms have been established, activities of other humanitarian organizations must be explored and integrated into the planning before humanitarian assistance programmes can be finalized. Planning of health services requires close coordination to avoid duplications and ensure that all essential needs are covered for all people in need (Perrin, P. 1996, 433).

Especially in acute emergencies coordination between dozens of humanitarian organizations can be hampered by lack of information sharing as well as incompatible communication systems (Burkle, F. 1999, 424).

Planning by one humanitarian organization may be further complicated by changes in programmes of other humanitarian organizations or their inability to obtain the necessary funds, which requires the former having to cover the needs at short notice.

Humanitarian organizations which lack the necessary expertise or funding to provide the whole range of essential services may depend on other humanitarian organizations. For example it is only sensible to provide health services if supply of water and food is assured. Small humanitarian organizations may depend on larger ones who outsource and pay for certain services.

While humanitarian organizations usually do not need to compete for customers they do compete for funding as well as for staff. Humanitarian workers not only need to be professionally qualified, they should also have experience in humanitarian assistance, be multilingual, be flexible, able to work under high stress and willing to take the risk of working in a conflict area. Human resources are particularly scarce where humanitarian organizations rely on volunteers or offer low remunerations (European Commission 1998d, 39). The often high turnover of staff results in lack of institutional memory (Weinberg, J., and St. Simmonds 1995, 1663).

According to a survey among humanitarian organizations only 45% of logisticians possessed any formal qualification in logistics, transport or related areas (Oloruntoba, R., and R. Gray 2003, 4).

The potential geographic scope of humanitarian assistance programmes is vast (European Commission 1998d, 40) and implementing humanitarian assistance programmes in several countries around the world requires complex management of global supply networks (Oloruntoba, R., and R. Gray 2003, 5).

Working internationally requires working in several different languages. In countries where languages commonly used internationally, for example, English, Spanish, French or Portuguese, are spoken staff with the required language skills can be recruited internationally. However in countries where languages which are rarely studied as foreign languages or various dialects are common, international staff will often require the help of translators for communicating. This is not only time-consuming but can lead to misunderstandings.

International humanitarian workers also need to adapt their conduct as well as assistance programmes to the regional, national and local culture and consider the difference in cultural perceptions and interpretations of behaviour, assistance and provided assistance goods (European Commission 1998a, 2).

Where goods and services are not purchased domestically, crossing international borders increases the complexity of logistics operations (Oloruntoba, R., and R. Gray 2003, 5) and compliance with national laws and regulations can cause significant delays. Importation of some types of goods such as communication equipment and drug products are often subject to stringent regulations and require prior registration and approval.

2.3.2 Less developed countries

Most armed conflicts take place in less developed countries (Mack, A. (ed.) 2005, 35), almost all deaths attributable to conflicts occur in less developed countries (Denny, Ch. 2005, 151) and needs for humanitarian assistance will be greatest in the least developed areas and countries (European Commission 2006, 5).

Some key indicators in high income or developed countries (DC), less developed countries (LDC) and least developed countries (LLDC) which are relevant for further

analysis are presented in table 2.1 and the data sources are presented in the appendix. The table also shows that all averages for less developed countries which were affected by complex political emergencies in 2005 are worse than averages of less developed countries in general. Consequently the constraints already encountered in less developed countries are even further compounded by complex political emergencies.

Indicator	High income or DC	LDC	LDC affected by CPE	LLDC
Corruption Perception Index	5.53	3.34	2.58	2.26
Kaufmann-Kraay indicator Rule of Law	0.51	-0.53	-0.94	-1.30
Paved roads (% of total)	95	38	34	19
Aircraft departures (thousands)	306	44	39	8
Telephone mainlines per 1,000 people	562	113	56	8
Cellular subscribers per 1,000 people	710	134	108	16
Personal computers per 1,0000 people	467	62	24	7
Internet users per 1,000 people	477	53	32	4
Per capita total expenditure on health in USD	1,573	272	156	55
Adult literacy rate	99	77	69	54
Under-five mortality rate	6	88	99	156
Physicians (per 100,000 people)	321	75	57	16
Human Development Index	0.91	0.69	0.58	0.52

Table 2.1 Comparison of indicators in developed and less developed countries

The lack of democratic traditions and structures in less developed countries is conducive to the collapse of state authorities, disintegration of states and the emergence of authoritarian rulers and (military) dictatorships.

The uncertainty about political developments makes mid- and long-term planning for humanitarian organizations difficult. Imminent political destablization poses particular problems where humanitarian organizations establish structures and services in less developed countries for supporting neighbouring countries suffering from complex political emergencies.

While corruption is an international problem, it is more widespread and pronounced in poor countries (see table 2.1), can jeopardize the humanitarian organization's credibility and lead to security threats (Mayhew, B. 2004, 65).

When confronted with obvious corrupt practices of commercial businesses and state authorities, humanitarian organizations are faced with a dilemma. On the one hand they are bound by their ethical standards and code of conduct as well as the obligation to accurately account for all of their expenditures. On the other hand corruption in combination with weak judicial systems can cause significant delays in importing goods or obtaining various permits and paying "charges" or "fees" may be unavoidable (Mayhew, B. 2004, 65). In countries where corruption is widespread and part of everyday life, there is also a danger that tendering or recruitment of staff is tainted by corrupt practices.

Inefficient administration can cause significant delays for, among other things, obtaining visas and travel permits, registration of vehicles and aircraft, importation of goods, obtaining licences for operating (medical) stores and warehouses or tax exemptions.

Apart from the problems these delays are likely to cause, humanitarian organizations must also devote valuable resources to the follow-up of administrative procedures.

Even in countries which are not plagued by inefficient administration, high levels of bureaucracy which require submitting a multitude of documents, obtaining various

approvals and signatures and involve a multitude of government authorities, are likely to cause significant delays for obtaining various permits.

Humanitarian organizations must take great care to comply with their code of conduct and follow rules and regulations meticulously. Even minor violations may not only have legal consequences but could be used by the authorities as a pretext to hamper humanitarian organizations which are critical about the authorities.

International logistics and supply chain management requires considering the national legal system and government regulations (Kummer, S., and H.-J. Schramm 2004, 77). Poorly developed legislation (see table 2.1) and especially poor legal security pose significant risks for concluding contracts and agreements. Enforcing contracts and indemnities may be literally impossible or require years of litigation. In addition high levels of corruption bear the risk of perversion of justice. Parties to contracts, especially suppliers of goods or services, may be tempted to take advantage of these circumstances and default on their contractual obligations.

Poorly developed pharmaceutical legislation and a domestic pharmaceutical market which is poorly controlled by state authorities facilitate importation of health care goods by humanitarian organizations. On the other hand protection of the domestic markets from counterfeit and substandard health care goods, both from domestic production as well as importation, will be low (WHO 1996a, 118).

Counterfeiting of drug products and other health care goods is a global public health problem which affects developed but predominantly less developed countries (WHO 2006). An estimated 10% of drug products worldwide, 25% in less developed countries and 50% in some countries are substandard or counterfeit (WHO 2006).

Production of counterfeit drug products is encouraged where competent authorities do not carry out the recommended regular inspections of manufacturing facilities (WHO 1992c, 17). According to the World Health Organization, national drug regulatory authorities should only permit importation of drug products which are licensed in the country of importation although waiving this requirement in emergency situations is recommended (WHO 1996a, 187).

A poorly developed financial infrastructure requires settlement of financial transactions in cash rather than by check or bank transfer. This may include paying a large number of staff or purchasing large amounts of goods with cash. In countries with weak currencies and high levels of inflation the physical transfer of large amounts of cash can pose significant security risks (Mayhew, B. 2004, 76). Moreover cash in domestic currencies might depreciate very quickly or may be devalued and must be spent quickly. Changing of money may be subject to legal restrictions, for example officially a privilege of state banks.

In less developed countries infrastructure in terms of transportation networks, warehousing facilities and distribution systems is generally insufficient (Simchi-Levi, D., Ph. Kaminsky, and E. Simchi-Levi 2003, 204).

Management and provision of logistics services is often hampered by poor transport infrastructures (Oloruntoba, R., and R. Gray 2003, 25) in less developed countries such as limited numbers and capacities of seaports and international airports. Rail networks are often poorly developed and services irregular and unreliable. Road networks are often poorly developed (see table 2.1) and maintained which limits the size and payload of heavy vehicles, significantly reduces vehicle speeds and increases the risk of accidents. Especially deliveries to final recipients may require the use of all-terrain vehicles.

Transport may also be hampered or blocked by poorly maintained or impassable bridges. Rivers without bridges which are usually passable at shallow places may be impassable during certain seasons. Weight limits of bridges may even require carrying goods across a bridge and loading onto another vehicle on the other side.

Poorly constructed and maintained roads may turn into mud during the rainy season and become impassable. In countries with severe winters, road transport may be interrupted by unavailability of equipment for removing snow as well as by avalanches.

The airline industry is less developed (see table 2.1) and airports and airstrips may be poorly maintained or information on their condition unavailable.

Importation of goods may be hampered by limited capacities of seaports, airports and border crossing points due to lack of handling equipment and lack of staff. Difficulties for importation can be compounded by high levels bureaucracy and corruption. In some countries the queuing of trucks for several days at borders is the rule rather than the exception.

This situation can quickly worsen when a large number of humanitarian organizations strain already limited infrastructure with the request to import large quantities of goods and equipment at short notice.

In many less developed countries warehouses and storage facilities may be unavailable (Lambert, R.S., and J.R. Stock 1993, 337) while services for port handling and road transport are usually offered by commercial companies.

Telecommunications networks are poorly developed (see table 2.1), often limited to the main cities and domestic as well as international connections can be unreliable. The use of computers is not as widespread as in developed countries (see table 2.1) and Internet and data communication networks (see table 2.1) are usually not widely available. The environment of less developed countries generally does not allow supporting advanced information technology such as bar coding or EDI (Simchi-Levi, D., Ph. Kaminsky, and E. Simchi-Levi 2003, 205).

Under these constraints information systems which require real time exchange of data such as EDI (Electronic Data Interchange) are not affordable. Especially in remote areas humanitarian organizations have to substitute any lack of telecommunications infrastructure by their own networks. In the absence of reliable landlines voice and data communications will require the use of radio or satellite communications. Since maintaining satellite connections permanently is prohibitively expensive, data exchange is restricted to regular up- and downloads.

The less developed economy as well as lower expenditure on health care (see table 2.1) limits the demand and therefore availability and quality of health care goods. Health care goods will often not be available domestically (PAHO 1983, VII) since their manufacturing requires expertise as well as investment in sophisticated equipment, which is mostly limited to advanced economies. Worldwide over 90% of drug products are manufactured in a few developed countries with two-thirds of drug products (in terms of value) manufactured by companies headquartered in only five countries (Creese, A., N. Gasmann, and M. Mariko 2004, 3). Most of the drug products available in less developed countries are imported (Menkes, D.B. 1997, 1557). Importers may offer a wide range of products but will not keep them in stock and rather import them only upon receipt of firm orders.

Since consumers are unable to check the composition and contents of drug products and drug testing requires sophisticated laboratories, counterfeit drug products are difficult to detect (WHO 1999, 35). Counterfeit drug products may be mislabelled with respect to the identity of their contents and/or the source, be sold in fake packaging or

contain little, the wrong or no active ingredient or even toxic substances (Forzley, M. 2006, 2). The decrease or absence of therapeutic, diagnostic or prophylactic value of counterfeit drug products can cause death, disability and injury (Forzley, M. 2006, 6).

Lack of legislation or enforcement of existing legislation, weak or absent national drug regulatory authorities, corruption, scarcity of drug products and high prices (WHO 1999, 15f.) as well as potentially high profit margins are conducive to trade in counterfeit drug products from domestic production as well as through international trade.

In many less developed countries purchasing of drug products does not require the prescription of health care professionals and the possibility of self-medication creates a large and lucrative market.

The relatively high value of medical devices, such as syringes and various catheters, and the difficulty of determining the quality and especially sterility also open a lucrative market. For example the illegal re-processing and re-packaging of used syringes for resale (Cheng, M. 2003, V). Moreover regulatory controls for medical devices and health care equipment are scarce in less developed countries (Cheng, M. 2003, V).

Because of high unemployment rates, labour is generally readily available. At the same time well educated and highly qualified staff, such as health care or logistics professionals, is likely to be scarce as staff will seek better employment conditions and career opportunities abroad.

High unemployment, low wages and very limited social benefits encourage employment of labour rather than investing in equipment and automation and may justify manually loading lorries or aircraft.

High levels of illiteracy (see table 2.1) and low levels of education in general imply difficulties in employing qualified and well trained staff, especially logistics professionals (Simchi-Levi, D., Ph. Kaminsky, and E. Simchi-Levi 2003, 205). While education levels tend to be higher in urban areas, recruiting literate and numerate staff with foreign language skills may be difficult outside urban areas. Moreover finding staff with good computer skills may also prove difficult.

In many countries where humanitarian organizations provide assistance, the practice of logistics is not developed (Oloruntoba, R., and R. Gray 2003, 5) and recruitment of experienced logistics professionals may be difficult.

Health care services are poorly developed, often chronically under-resourced, concentrated in urban areas and offer a limited range of specialist services. As an indicator, table 2.1 shows differences in child mortality rates. The number of health professionals is low (see table 2.1) and populations in rural areas often have to rely on health care workers with limited professional training.

Although health care goods are usually readily available in the market, due to financial constraints of governments and authorities, shortages in health care facilities are common. In 2000 the populations of middle-income countries, which account for half the world's population, consumed only 10% of worldwide production of drug products and the populations of low-income countries, which account for 36% of the world's population, purchased less than 1% of worldwide production (Creese, A., N. Gasmann, and M. Mariko 2004, 33). A quarter of the world's population (1.7 billion people) and half of the population in Africa do not have access to essential drug products (Creese, A., N. Gasmann, and M. Mariko 2004, 61).

Logistical support to health care facilities in less developed countries is neglected and poorly planned. Storage facilities are often inadequate and poorly managed and poor distribution management results in delays, spoilage and losses of critical supplies

(Tarimo, E., and E.G. Webster 1997, 33). Patients or relatives are often obliged to purchase necessary drug products and equipment in the market and provide them to the respective health professionals for treatment or surgical operations.

High temperatures and humidity in (sub)tropical countries require special measures to prevent drug products from degradation and spoilage.

2.3.3 Complex political emergencies

Humanitarian organizations are faced with "uncountable constraints" (Russbach, R., and D. Fink 1994, 1) in armed conflicts and delivery of humanitarian assistance in armed conflicts is difficult (Weinberg, J., and St. Simmonds 1995, 1663).

Complex political emergencies are characterized by high degrees of instability (European Commission 1998d, 40) which are caused by collapsed, contested or seriously weakened states (Gundel, J. 1999, 4).

Even where formal state authorities may still exist, they are unable to exercise power or control over the state territory. This void is filled by a multitude of (illegitimate) actors such as paramilitaries, separatists, insurgents, rebels, vigilantes, militias, mercenaries, warlords, irregular fighters and criminal gangs.

These actors have disparate interests (European Commission 1998d, 40) and are virtually uncontrollable (Trintignac, F. (ed.) 1999). Where access is not free humanitarian organizations have to negotiate access to each territory with the respective actors which exert actual control (Ebersole, J.M. 1995, 19).

Since state authorities are weak or even absent they cannot fulfill their responsibility of coordinating humanitarian assistance efforts. Moreover weakend state authorities, their remnants or other conflict parties will divert any available resources to the armed conflict and may not be able or willing to provide for the population.

The inability of any state authority to exert control over their territory leads to the breakdown of the rule of law, the absence of any effective regulatory framework (Leader, N. 2000, 10) and therefore the lack of legal security for humanitarian organizations.

State authorities can no longer be held accountable for breaches of international (humanitarian) law. Humanitarian organizations can also not rely on any intervention, protection or assistance in case of violations of laws such as theft, looting or damage to property. Contractual agreements, for example renting of warehouses, purchasing of goods or employment of staff, are concluded at the risk of humanitarian organizations since breaches cannot be prosecuted.

As a consequence of the breakdown of legitimate government institutions (Milwood, D. (ed.) 1996), immigration authorities cease their services, customs authorities are no longer controlling and administering importation of goods and national drug regulatory authorities no longer control the importation, storage or distribution of health care products.

The lack of commercial regulations often results in the development of "war economies" (OECD 1999, 7) which engage in activities which would be illegal under normal circumstances. Since control of wealth is often one of the causes of conflicts, war economies can prolong conflicts.

Regardless of whether the actors exerting control are legitimate or not, humanitarian organizations depend on their permission for entering their territory and on their consent for carrying out humanitarian assistance programmes.

Crime and banditry, encouraged by the absence or weakness of state authorities, as well as the conflict itself cause insecurity and high levels of violence (Burkle, F. 1999, 422). The insecurity poses risks for the general population, recipients, humanitarian workers (European Commission 1998d, 40) as well as humanitarian assistance goods and assets. Within a country or even a region the level of insecurity may differ significantly. While some areas may be relatively peaceful others can be affected by violent conflict at the same time (OECD 1997, 11).

Despite their protection under international humanitarian law (Bruderlein, C. and J. Leaning 1999, 430), increasingly civilians and their livelihoods are not only indirectly affected by the conflict but are becoming direct targets (OECD 1999, 7). Woman, children and health care facilities are deliberately and indiscriminately attacked (Burkle, F. 1999, 425). Where civilians become part of the conflict, humanitarian workers providing assistance to them can no longer rely on being considered as impartial (Makinlay, J. (ed.) 1996, 20) and are also being deliberately targeted (Krähenbühl, P. 2004, 505). Moreover differentiating between combatants and civilians is becoming more and more difficult (OECD 1999, 7) and combatants may benefit from humanitarian assistance provided to civilians.

Before the end of the Cold War security of humanitarian workers was no major concern. Despite their protection under international humanitarian law, violence against humanitarian organizations and their staff have since become a daily routine (Schneider, M. 2003, 138). Threats against the safety and security of United Nations personnel have escalated at an unprecedented rate during the 1990s (United Nations General Assembly A/57/300, 2002). In nearly all conflicts humanitarian workers have fallen victim to threats, injuries, kidnapping, robberies, sexual assaults and 350 humanitarian workers from the United Nations and Red Cross movement alone have been murdered between 1992 and 2001 (Schneider, M. 2003, 139). The concern over the growing number of deaths and injuries from deliberate attacks on humanitarian workers has led to establishing the Convention on the Safety of United Nations and Associated Personnel (UN General Assembly Resolution 49/59, 1994).

Humanitarian workers may become victims of various crimes such as threats, harassment, illegal arrests, robberies, abductions, physical abuse or injuries (UN Security Council Resolution 1502, 2003) while humanitarian assistance goods and assets may be looted, confiscated, stolen or vandalized. Humanitarian organizations may also be affected by conflict related dangers such as indiscriminate attacks, ambushes, threats from various types of fire arms, a wide range of explosive devices such as anti-personnel mines, grenades, improvised explosive devices and car bombs, shelling with mortars, artillery and rockets as well as aerial bombs (Roberts, D.L. 2005, 41). An overview of threats is given in table 2.2.

International borders may be closed either by the conflict parties themselves or by neighbouring states which want to prevent combatants or displaced populations from entering their territory.

In these situations humanitarian organizations will have to negotiate passage of humanitarian assistance goods, humanitarian workers and evacuated civilians with all parties in control of the respective territories or use alternative access routes.

Humanitarian organizations need to obtain consent and cooperation of the parties in control to gain access to the conflict area and to the people in need (The Sphere Project 2004, 13), an indispensable condition for providing humanitarian assistance.

Despite obligations under international humanitarian law, access is often hindered (Russbach, R., and D. Fink 1994, 8) and frequently even denied (Trintignac, F. (ed.) 1999).

a) Criminality

Threats
- Verbal abuse
- Slander and defamation
- Verbal threats
- Written threats
- Bomb threats
- Harassment
- Blackmailing
- Extortion

Offences against property
- Theft
- Burglary
- Robbery
- Arson
- Vandalism
- Sabotage

Physical harm
- Physical abuse
- Mistreatment
- Beating
- Physical assault
- Sexual assault
- Torture
- Murder

b) Armed banditry
- Hold-ups
- Abduction
- Kidnapping
- Hijacking
- Carjacking

c) Conflict related risks

Peaceful protests
- Strike
- Crowds
- Protests
- Demonstrations
- Blockades
- Sit-ins
- Occupation

Lawlessness
- Unlawful arrest and detention
- Expropriation
- Confiscation
- Expulsion
- Riots
- Looting

Terrorism

Forms of attack
- Ambush
- Indiscriminate attack
- Attacking a specific target
- Targeting individuals

Shooting
- Small arms
- Rifles
- Automatic guns
- Snipers
- Execution

Explosive devices
- Anti-personnel mines
- Anti-tank mines
- Booby traps
- Hand grenades
- Grenades
- Rocket propelled grenades
- Improvised explosive devices
- Bombs
- Car bombs
- Unexploded ordnances

Artillery (shelling)
- Mortar fire
- Howitzers
- Heavy artillery
- Rockets
- Anti-aircraft guns

Aerial bombing
- Bombs (explosives)
- Fragmentation bombs
- Cluster bombs
- Incendiary devices (Napalm)

Other weapons
- Chemical
- Biological
- Nuclear

Table 2.2 Classification of threats to humanitarian organizations

According to Art. 70 of the First Protocol Additional to the Geneva Conventions, parties to the conflict must allow and even facilitate humanitarian assistance and withholding of humanitarian assistance can constitute a war crime (Rottensteiner, Ch. 1999, 580). Conflict parties must allow free passage of humanitarian assistance goods to territories under control of the adverse party but have the right to search consignments and regulate their passage.

Access of humanitarian organizations in general as well as provision of humanitarian assistance goods might be restricted, obstructed or denied directly (Bruderlein, C. and J. Leaning 199, 431) by physical means such as road blocks, mining roads and bridges, by threats to use force or by military means such as direct attacks. Besides conflict parties may resort to more subtle means (Rottensteiner, Ch. 1999, 559-560) such as denying humanitarian workers visas or travel permits, granting staff access but being unable to guarantee their security, denying the use of telecommunications equipment essential for safety and security of staff or imposing unacceptable conditions such as demanding fees and customs duties or determining the beneficiaries. Provision of humanitarian assistance can be delayed by requesting

additional documentation and permits for staff or consignments, lengthy inspections of consignments, possibly requiring vehicles to be completely unloaded as well as threatening or carrying out confiscations. Authorities may refuse or delay providing security escorts or deny overflight and landing permissions for aircraft.

During armed conflicts authorities often deliberately restrict people's movements by imposing curfews, enforcing roadblocks and travel restrictions and closing borders (Slim, H., and A. Bonwick 2005, 26). Since in most cases humanitarian assistance cannot be physically provided to each recipient, access of people to locations where goods or services are provided are of equal importance.

Access to health care facilities can be impeded for several reasons (Perrin, P. 1996, 322). Great distances and unavailability of means of transport cause physical or geographical inaccessibility while lack of financial resources may make available treatment unaffordable. Increased demand for health services during crises may lead to social inaccessibility where disadvantaged groups are denied access. Discrimination against groups because of their political affiliations, ethnicity, religion or support of a conflict party may make health care facilities politically inaccessible. Finally safe access to health services may be blocked by warfare (Guha-Sapir, D., and W. van Panhuis 2002, 19) or by destruction of transport routes (Perrin, P. 1996, 319). People may also be too afraid to seek health care services from facilities even if they are accessible (Slim, H., and A. Bonwick 2005, 26).

Humanitarian organizations may negotiate cease-fires to allow safe passage of humanitarian assistance goods or access of people in need to distribution points or health care facilities (OECD 1997, 15).

Economic sanctions are among the measures the Security Council can take under Chapter VII of the United Nations Charter to maintain or restore international peace and security (Gasser, H.-P. 1996, 872). Transportation sanctions which interrupt road and rail links as well as sea and air transport may hamper access to critical health care goods (Bessler, M., R. Garfield, G. Mc Hugh 2004, 20). Vital voice and data transmission to suppliers outside the conflict area may be hampered by interrupted communication links (Grasser, H.-P. 1996, 879) and trade sanctions may reduce variety and availability of health care goods in the domestic market. Obtaining approval for import permissions for humanitarian assistance goods from the United Nations Security Council can take months (Forte, G.B. 1994, 6).

Obtaining exemptions from sanctions according to international humanitarian law (Minear, L., et al. 1998, 55) and complying with sanction committee procedures can delay shipments. Items such as telecommunication equipment or vehicles which could be diverted and abused by conflict parties will be particularly scrutinized.

Armed conflicts and the resulting complex political emergencies may erupt suddenly (Ballance, S. (ed.) 2005, 1), even if their causes go back years or even decades. On the other hand complex political emergencies may develop slowly, alternate between relative peace and extreme violence (Slim, H. 1997) or show seasonal patterns.

Conflicts and the resulting complex political emergencies are unpredictable and dynamic processes (OECD 1997, 11). Situations and front lines often change rapidly and unexpectedly (European Commission 1998b, 50). In long lasting conflicts fairly stable situations may suddenly exacerbate, creating urgent needs for humanitarian assistance, and recede again (OECD 1999, 7). In cases where military preparations indicate imminent warfare or when a conflict party gives an ultimatum, the onset of hostilities may be quite predictable.

Complex political emergencies are often protracted, lasting many years and even decades and have therefore been called "permanent emergencies" (Slim, H. 1997).

Insecurity, possibly trade sanctions, domination of trade by conflict parties as well as displacement discourage economic activities and disrupt trade of essential goods or even cause the collapse of local and domestic economies. Health care goods will become scarce and transport may be hampered by fuel shortages.

Lack of state authorities and the deteriorating economic situation will lead to a neglect of the infrastructure and its maintenance. Besides civilian structures such as airports, ports, railway stations and railways, main roads, bridges and tunnels are often primary targets (OECD 1999, 7) or are inadvertently damaged during warfare. In extreme cases conflict parties may pursue a scorched earth policy (European Commission 1998e, 7) and try to destroy as much infrastructure as possible. The targeting of power and transformer stations as well as fuel depots causes the collapse of the energy supply system.

Damage or destruction of telephone networks or radio stations, which are often the first targets in a conflict (Collier, P. et al. 2003, 14), can cause the rapid collapse of the telecommunications infrastructure. The increased centralization of domestic and global public telecommunication networks has increased their vulnerability (Klenk, J.S. 1997, 44).

The lack of state authorities, decrease of state revenue and lack of foreign currency will lead to a general lack of financial means and weaken national health systems (Perrin, P. 1996, 324). Health expenditure is usually drastically reduced in conflicts although demand for health services increases (Kalipeni, E., and J. Oppong 1998, 1645). Armed conflict directly affects all contributors to health and increases the risk of disease, injury and death (Ghobarah, H.A., P. Huth, and B. Russett 2004, 871).

Unpaid health professionals will be forced to seek alternatives for earning a living (Guha-Sapir, D., and W. van Panhuis 2002, 19) and are often the first to leave the country (Ballance, S. (ed.) 2005, 12). The degradation or suspension of national education systems as well as the departure or killing of professionals (Mackinlay, J. (ed.) 1996, 18) cause acute shortages of health staff and cause further deterioration of health services.

Already fragile and under-resourced health care facilities may be looted, damaged or destroyed by inadvertent bombing or shelling as well as by deliberate attacks (Guha-Sapir, D., and W. van Panhuis 2002, 19). These problems are compounded by the interruption of distribution systems for supplying health care facilities, the loss, damage or destruction of equipment and the lack of drug products and other health care goods (Ockwell, R. 1994, 72). Armed conflicts cause deterioration of health services which are often already inappropriate even before the conflict (Macrae, J., A.B. Zwi, and L. Gilson 1996, 1095).

Preventive, curative as well as rehabilitation services can be affected and deteriorate. Preventive care will be affected by a reduction of immunization coverage which increases the risk of epidemics (Guha-Sapir, D., and W. van Panhuis 2002, 20) as well as by disruption of prenatal care which increases infant and maternal mortality (Kalipeni, E., and J. Oppong 1998, 1638). The suspension of measures and programmes for controlling vectors also increases the incidence of communicable diseases (Perrin, P. 1996, 154).

The percentage of civilians among the casualties increased from 5% during the First World War to 50% during the Second World War (European Commission 1998f, 4). During the cold war civilians accounted for by far the greatest number of casualties through direct or indirect effects of armed conflicts (Mackinlay, J. (ed.) 1996, 13). The repeated claim that 90% of people killed directly or indirectly by armed conflicts has been described as completely unfounded (Mack, A. (ed.) 2005, 75). However in

protracted conflicts in poor countries the indirect effects of armed conflicts account for the vast majority of deaths und in some conflicts more than 90% of victims were civilians (Lacina, B., and N.P. Gleditsch 2005, 159).

This dramatic increase is not an inadvertent side effect but rather the result of disregard and blatant violations of international humanitarian law, where civilians are being deliberately targeted and attacked (Schneider, M. 2003, 139). The distinction between combatants and non-combatants, the very foundation on which international humanitarian law rests, is being eroded (Leader, N. 2000, 2) and civilians have become the objective and focus of armed conflicts (ECHO 1999, 80). Among the civilians, children and woman are most vulnerable and account for the great majority of the civilian victims (European Commission 1998e, 4).

Machetes, fire arms, varies types of mines and grenades, shelling, bombs, incendiary devices and as well as chemical weapons cause (gun shot) wounds, traumatic amputations, crush injuries, burns and poisoning which in turn result in psychological trauma, injuries, permanent disabilities, mutilation and death (Perrin, P. 1996, 224). Tripling the number of deaths provides an indication of the number of injured combatants and non-combatants in armed conflicts (Russbach, R., and D. Fink 1994, 3).

Civilians do not only suffer from direct violence of warfare but are also affected indirectly by deterioration of their nutritional status, lack of safe water, poor sanitary conditions, displacement and overcrowding as well as deterioration of health services (Perrin, P. 1996, 396). Mortality rates among refugees which have newly arrived in a neighbouring country have been reported to be up to 12 times as high as normal rates (Ghobarah, H.A., P. Huth, and B. Russett 2004, 872). Consequently complex political emergencies need to be recognized as public health disasters (Burkle, F. 1999, 422) which require a public health response.

Although counter-intuitive, with the exception of genocide, the great majority of deaths in armed conflicts can be attributed to indirect causes rather than direct violence and ironically the safest place in contemporary conflicts may be the army (Slim, H. 1997). An analysis of nine major armed conflicts in sub-Saharan Africa found that battle-deaths accounted for as little as 2% and on average for 6-8% of deaths while the majority of deaths were caused by disease and malnutrition (Mack, A. (ed.) 2005, 127).

The combination of increased prevalence caused by poor nutritional status, deterioration of preventive services and impaired access to curative health services and the increased seriousness of medical conditions caused by delayed treatment result in an overall increased mortality (Perrin, P. 1996, 192).

With maternal and child health often already precarious in peace times (European Commission 1998e, 5), children, (pregnant) woman and the elderly are most vulnerable to the indirect effects of armed conflicts (Guha-Sapir, D., and W. van Panhuis 2002, 17). The highest mortality rates are found among children under five years of age affected by armed conflict (Zwi, A. et al. 2006, 1886).

Another reason for the increase in the number of sick people, which would be treated and would recover in the absence of the armed conflict, is the degradation or collapse of health services (Sondorp, E., and A.B. Zwi 2002, 310). Compared to peace time demand, conflict related injuries increase the overall demand for health services (Perrin, P. 1996, 321).

Even health care facilities which have not been adversely affected by the armed conflict may be overwhelmed with injured patients as well as by the need to serve a population which has suddenly and significantly increased due to the arrival of

displaced people in the community (Perrin, P. 1996, 324). Moreover providing displaced but not host populations with humanitarian assistance can cause diversion and conflict.

Compared to peace times the extent of health needs of displaced populations in complex political emergencies increases two- to threefold (Perrin, P. 1996, 301). The main cause for mortality among displaced populations is the spectacularly high rate of infectious diseases (Guha-Sapir, D., and W. van Panhuis 2002, 19). The negative impact on public health persists up to ten years after hostilities cease (Mack, A. (ed.) 2005, 131) and the increase of infant mortality persist almost at the same level during the five years after the armed conflict ends (Collier, P. et al. 2003, 24). In the aftermath of armed conflicts health services will be allocated less resources, they are used less efficiently and damaged health care facilities may take years to restore (Ghobarah, H.A., P. Huth, and B. Russett, 872). One study estimates that twice as many deaths were caused by the aftermath of conflicts from previous years than through direct and immediate effects of armed conflicts in 1999 (Ghobarah, H.A., P. Huth, and B. Russett, 870).

Overcrowding, lack of food and clean water, poor sanitary conditions as well as a decrease in immunization coverage and lack of health services are conducive to the spread of infectious diseases (Perrin, P. 1996, 127). However except for measles and cholera, epidemics are rare (Simmonds, St., P. Vaughan, and S. W. Gunn (ed.) 1986, 36).

The most frequent infectious diseases among displaced populations are measles, diarrhoeal diseases, acute respiratory infections and malaria (Hanquet, G. (ed.) 1997, 41). Together with malnutrition these diseases account for up to 95% of deaths among displaced populations (Hanquet, G. (ed.) 1997, 41).

According to the World Health Organization up to 30% of the almost one million annual deaths from Malaria in Africa occur in countries affect by humanitarian emergencies (WHO 2000, 1) and malaria often kills more people than the direct effects of armed conflicts.

Complex political emergencies often affect entire countries or large regions and sometimes even spread to neighbouring countries by drawing them into the conflict or by displacement of populations across international borders (Mack, A. (ed.) 2005, 132). Even if an armed conflict does not spread, public health in neighbouring countries is adversely affected and deteriorates mainly due to an increase of infectious diseases (Ghobarah, H.A., P. Huth, and B. Russett 2004, 880).

Since patients will only visit a health care facility if it is within a reasonable distance of their home (Perrin, P. 1996, 318), a fairly large number of health care facilities must be maintained in order to provide health services for the entire population.

The unpredictability of the conflict implies that the number as well as location of people in need is difficult to anticipate. Military attacks can suddenly increase the number of wounded and the disruption of water supplies can increase the prevalence of infectious diseases. The (deliberate) damage or destruction of health care facilities (Slim, H., and A. Bonwick 2005, 26) and the breakdown of health care systems (Ballance, S. (ed.) 2005, 1) can create an immediate need for substitution. The lifting of military blockades and sieges, which deprive the civilian population of health services, can suddenly create large and urgent needs for humanitarian assistance.

Complex political emergencies often lead to displacement of large populations (Guha-Sapir, D., and W. van Panhuis 2002, 17) which try to escape from violence and persecution or which are no longer able to sustain their livelihoods at home. The

number of people, speed of displacement and the direction they flee in may be unpredictable as they depend on the development of the conflict.

Populations may also move to places where they expect to have better access to humanitarian assistance such as distribution of food or household goods. Patients, who can (no longer) afford paying for health services, may seek free treatment offered by humanitarian organizations elsewhere (Perrin, P. 1996, 319).

For several reasons mentioned above, demand for health care goods will change with the unpredictable developments of the conflict, prevalence of medical conditions as well as movements of populations. The need for humanitarian assistance will also depend on changing capacities of health care facilities.

The place of need, the type as well as the quantities of required health care goods can change quickly and unpredictably.

A sudden increase in demand for health care goods may be caused by an influx of wounded patients, seasonal increases of diseases and epidemics, occurrence of diseases which are not endemic or changes in treatment protocols.

Even where demand for health care goods is fairly steady, irregular and unsystematic ordering, miscalculations as well as damage, destruction or unanticipated expiry of stocks can cause irregular and erratic ordering. Health care facilities may also make large requests to take advantage of free donations rather than basing requests on actual demand. The breakdown of (poorly maintained) health care equipment may cause a sudden, unexpected and urgent order for its replacement.

Changes in assistance programmes can also cause sudden changes in demand for example by extending assistance to other departments or services within a health care facility, increasing the number of assisted health care facilities or extending assistance to health care facilities in other cities or areas.

Demand may be particularly erratic where health care facilities already receive (irregular) support and humanitarian organizations only fill gap when shortages occur.

Due to the general economic decline or collapse, loss of income as well as displacement, people may no longer be able to pay for health services. Humanitarian organizations may have to assist health care facilities which are no longer able to recover costs from patients.

In many complex political emergencies humanitarian assistance must be provided immediately (European Commission 1998d, 40) in order to save lives and prevent outbreaks of infectious diseases.

Since health care goods are not useful for everyone and less coveted by the conflict parties, they are less prone to diversion and theft than for example food, vehicles or fuel. Nevertheless health care goods may be diverted by combatants for their own use. Health care professionals, often underpaid or not paid for a long time, may steal goods either for use in their private practice or to make money.

Diversion and theft cause unexpected increases in demand, may deprive patients of health care goods and lead to allocation of resources to individuals for which the assistance was not intended.

2.4 Health care goods

Supplied products and their physical characteristics are one of the major considerations for logistics planning (Rushton, A., J. Oxley, and Ph. Croucher 2000, 91).

Preventive health care, diagnosis, medical and surgical treatment as well as nursing care and physical rehabilitation require a wide range of different health care goods which have specific characteristics and are susceptible to deterioration and damage during storage and transport.

2.4.1 Classification

Health care goods can first of all be divided into expendable goods which can only be used once and non-expendable health care equipment. Medical kits, which are standardized and contain a number of different health care goods in predetermined quantities (Quick, J.D. (ed.) 1997, 408), will be considered as expendable although they may contain some health care equipment (figure 2.4).

Expendable goods can be divided further into drug products and disposable health care devices. Drug products are substances or mixtures of substances that are intended for treatment, mitigation, cure, prevention or diagnosis of diseases, abnormal physical states or symptoms, abnormal physiological conditions or the restoration, correction or modification of organic functions in humans (WHO 1997, vol. II, p. 165).

Drug products are often categorized by therapeutic groups such as anaesthetics, anti-effective drugs, cardiovascular drugs, disinfectants or psychotherapeutic drugs (WHO 1998a, 26 ff.). However the physical characteristics, which largely correspond to the route of administration (Aulton, M.E. 1988, 1) and also determine storage requirements, are of greater importance for logistics and supply chain management.

Drug products are manufactured in a large variety of different drug dosage forms (WHO 1997, vol. I, p. 206) such as ointments, sprays, tablets, capsules, solutions for injection, aerosols and gases.

Disposable health care devices can be classified by types which correspond to their function and field of application, such as dressing materials, catheters, injection materials, gloves or surgical sutures. Disposable products, many of which are sterile, can be used only once and must be discarded after use. Some devices such as certain injection devices, tubes or catheters may be available as disposable or reusable products. However since reusable goods carry the risk of transmitting diseases if they are not cleaned and sterilized properly, disposable goods are safer and generally preferred.

Health care facilities require a wide range of furniture as well as mechanical, electrical and electronic equipment for laboratory diagnosis, diagnostic imaging, anaesthesia, sterilization and especially surgery. Some pieces of equipment require various accessories (Kaur, M. et al. 2005, 56) such as filters, calibration liquids or disposable parts for operation and require stocking replacement parts such as batteries, fuses, light bulbs or heating elements as well as special cleaning materials.

Kits are self-contained assortments of carefully selected goods in predetermined quantities which are designed for providing specific services such as first aid, medical treatment in a clinic or immunization services. Self-sufficient field hospitals which include medical services as well as power and water supply are an extension of the kit concept. However, field hospitals should only be deployed (temporarily) if local capacities are exceeded and wherever possible, humanitarian organizations should assist existing health care facilities (The Sphere Project 2004, 263).

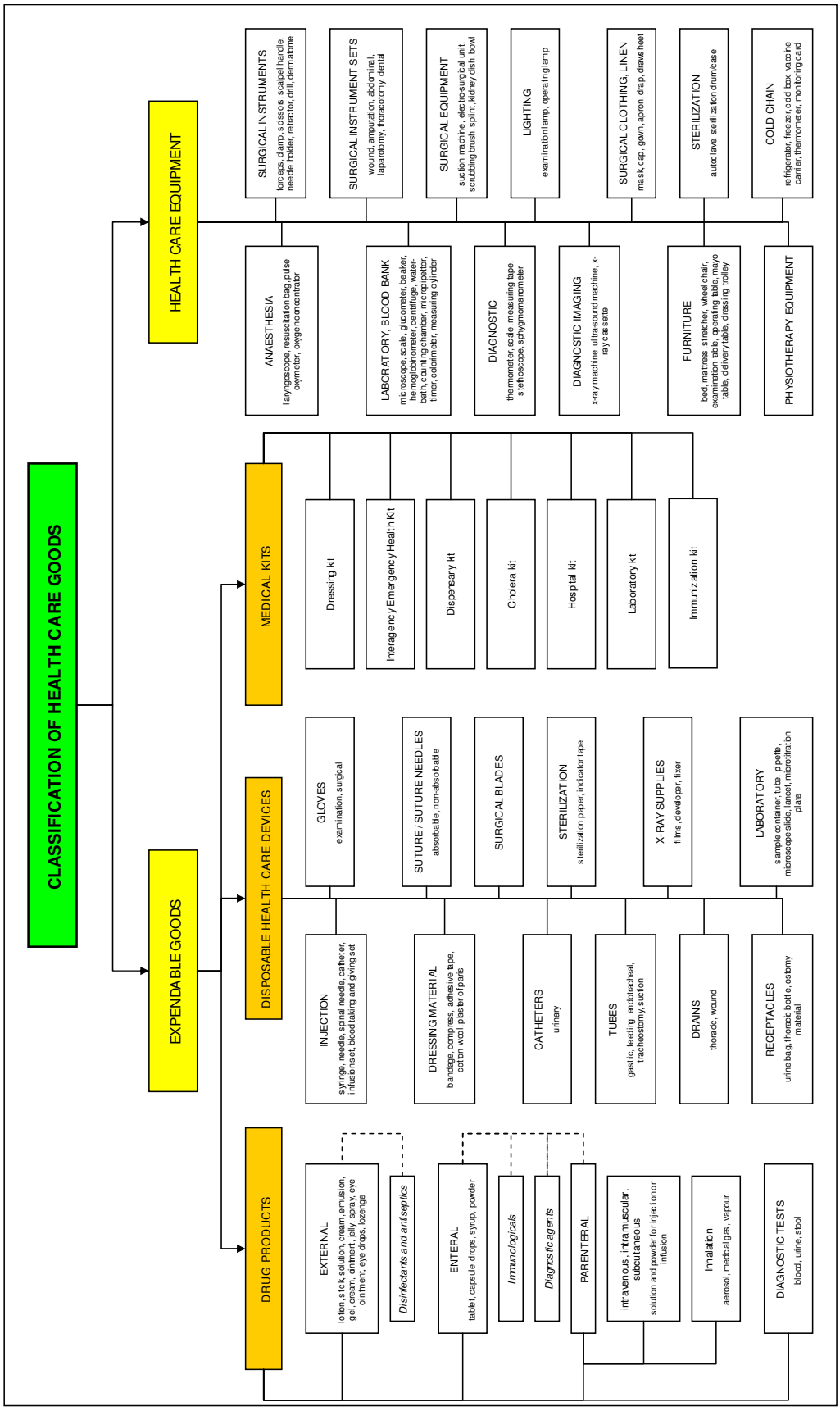

Figure 2.4 Classification of health care goods

2.4.2 Characteristics

The different characteristics of health care goods have important implications for their purchasing, packing, handling, storage, transport and distribution.

Relevant physical characteristics are weight, volume and physical state. Liquid dosage forms such as infusions and disinfectants or x-ray supplies are heavy and have high densities. Other dosage forms such as pressurized containers, for example inhalers, may be subject to restrictions for air transport. Various disposable products as well as instruments are sharp or pointed and require special care during handling. Many dressing materials, such as gauze or cotton, are light but bulky while furniture, for example operating tables, and some equipment, such as autoclaves or x-ray machines, is bulky and heavy.

Some chemical characteristics are important for storage and transport, especially by air. Some liquids used for laboratory diagnostics, which often contain alcohol, are flammable and disinfectants may be corrosive.

Injectable drug products and some other dosage forms as well as injection material, catheters, drains and surgical gloves are sterilized after manufacturing and require enclosure in special packaging until opened for use. All drug products and sterilized products have limited shelf lives and must be used before expiry.

Some drug products, especially diagnostic tests, sutures and health care equipment can have significant values.

Finally drug products which can be abused or are precursors of addictive drugs are subject to the Single Convention on Narcotic Drugs (1961) and the Convention on Psychotropic Substances (1971) as well as to special regulations at national level. Importation of drug products subject to international control requires obtaining an import authorization from the competent authorities which is then submitted to the competent authority of the exporting countries for obtaining an export authorization (WHO 1996a, 193).

2.4.3 Deterioration and damage

Health care goods in general and drug products in particular, can be adversely affected by chemical, biological, environmental as well as mechanical influences (figure 2.5). When active ingredients decompose, the efficacy of drug products is reduced, the toxicity and risk of allergies can increase and the remaining shelf life is reduced (Dörner, G. (ed.) 1992, 33).

The deterioration and spoilage of some drug products will be obvious through discoloration or production of gas and odours while in other cases the active ingredient degrades without any visible signs (Aulton, M.E. 1988, 483). Some health care goods are very sensitive and can be destroyed by incorrect handling or even by a brief period of inappropriate storage (Dörner, G. (ed.) 1992, 6).

Exposure to atmospheric gases can cause oxidation of ingredients and carbon dioxide can lead to a shift of the pH which in turn may adversely affect stability (Aulton, M.E. 1988, 218).

Liquid water or water vapour can cause hydrolytic reactions which are one of the major causes of drug degradation (Aulton, M.E. 1988, 242) and may result in the formation of inert or toxic byproducts (Aulton, M.E. 1988, 363).

Drug products can be contaminated by or interact with packaging material leading to, among others, degradation, increased toxicity and colour changes (Aulton, M.E. 1988, 219).

Drug products contaminated with bacteria cause infections, especially after parenteral administration and contaminated ophthalmic preparations have caused blindness. Pyrogens, either bacterial cells or endotoxins produced by bacteria, are not destroyed through sterilization and cause increases in body temperature. Microbial contamination can also be caused by moulds, which can produce mycotoxins, as well as yeasts (Aulton, M.E. 1988, 219).

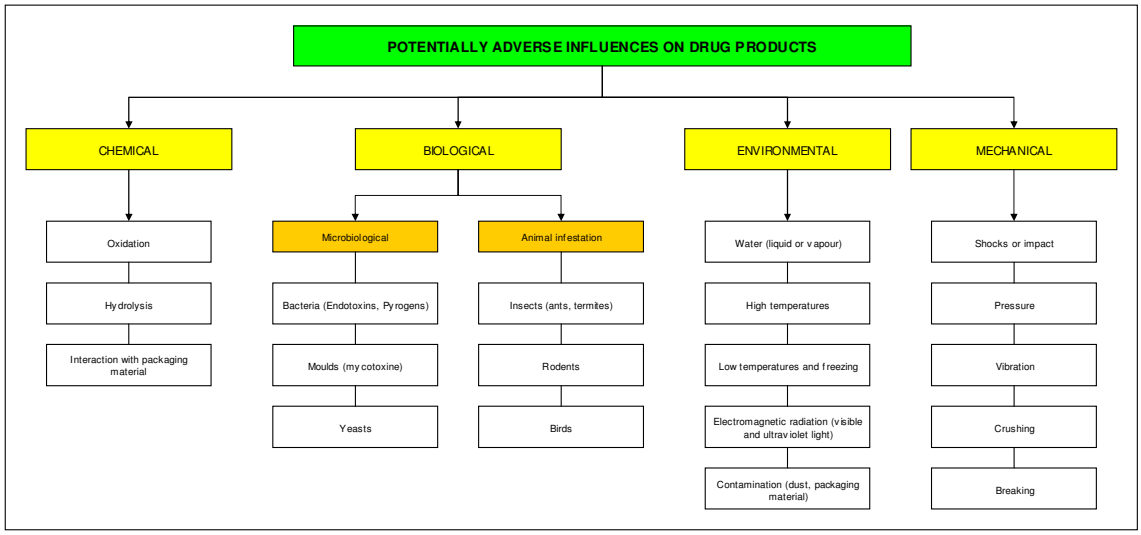

Figure 2.5 Potentially adverse influences on drug products

Insects, rodents or birds can cause damage to packaging as well as contamination of drug products.

Water, like other liquids or vapour, can induce decomposition by chemical reactions, cause physical changes, such as softening or hardening, and facilitate growth of bacteria and moulds (Aulton, M.E. 1988, 217).

Thermal energy generally increases the rate of chemical reactions and a 10° Celsius raise in temperature will increase decay of ingredients 2-5-fold (Aulton, M.E. 1988, 243). Exposure to high temperatures can cause separation of phases in an emulsion which leads to inhomogenous distribution of active ingredients and administration of incorrect dosages (Aulton, M.E. 1988, 294). Cold chain drug products, such as vaccines, must be stored between 2-8° Celsius from the time of manufacturing until administration (Dörner, G. (ed.) 1992, 28), will be damaged or destroyed by warming and may be destroyed by freezing.

Temperature fluctuations can also cause the deterioration of drug products or packaging as well as condensation which in turn can encourage growth of bacteria and moulds (Aulton, M.E. 1988, 217).

Electromagnetic radiation from sunlight, sky light, artificial and in particular fluorescent light as well as ultraviolet light can induce chemical reactions which cause photolysis and photodegradation of drug products (Aulton, M.E. 1988, 254). Light can catalyze oxidation and hydrolysis or the energy is converted to heat which in turn can cause deterioration.

Drug products can be contaminated by packaging material such as plastic or glass particles as well as dust and sand from the environment.

Drug products, such as tablets, can be damaged by rough handling such as dropping or by impacts during transport. Mechanical damage may also be caused by compression and crushing of drug products by heavy loads stacked on them.

Damage to packaging can cause leakage of liquids, spillage of powders, contamination of drug products and removes protection from radiation, oxygen, and humidity. Sterility of products will be compromised as soon as packaging is damaged (Cheng, M. 2003, 5). Paper material which is used for packaging some sterile materials only provides a barrier against microorganisms as long as it remains dry.

Like health care goods, packaging can be damaged by impacts, breaking, tearing, vibration and crushing as well as be punctured or cut by sharp objects. Mechanical forces can cause abrasion of labels which may lead to loss of important information. Damage to pressurized containers such as inhalers will incapacitate the drug delivery system and make them unusable.

3 DEVELOPMENT OF A SUPPLY CHAIN MANAGEMENT FRAMEWORK

Every organization must develop a formal supply chain management strategy in order to avoid wasting resources and realizing the potential of supply chain management (Harrison, A., and R. van Hoek 2002, 210). The use of modern management techniques allows improving the effectiveness and quality of humanitarian assistance (European Commission 1998d, 1).

According to Christopher (1998, 48), logistics strategies should be devised in a sequence of three steps. The objectives of humanitarian organizations, the context in which they work and the constraints they are subject to were discussed in the previous chapter. The logistics and supply chain management objectives will be developed and determined in the following sub-chapter. Finally the supply chain management framework (chapters 4 to 6) will be designed to suit the objectives of humanitarian organizations.

The feasibility, constraints and costs of logistics services must be an integral part of planning humanitarian assistance programmes. Health programme managers need to weigh the potential benefits of assistance programmes against the required resources of different interventions.

However this framework is developed on the premises that once health programme managers have determined their objectives and defined their interventions, logistics managers must provide the required services to enable and support these health care programmes. Logistics managers should be involved in the planning of humanitarian assistance programmes, can point out constraints and present different options for providing services. However humanitarian assistance programmes must be designed according to the needs of assisted populations and the professional expertise of health programme managers rather than according to logistical considerations.

The developed framework will not provide immediate solutions for individual humanitarian assistance programmes and situations. Instead the framework intends to be a decision support system for logistics and supply chain management which can be applied to specific health care programmes of a given humanitarian organization in a specific context. The framework indicates factors which favour certain decisions but does not allow mathematically deducting optimal solutions. Instead, decision making requires considering a multitude of trade-offs between favourable and unfavourable factors in the given context and situation.

3.1 Logistics and supply chain management objectives

Logistics services of commercial and humanitarian organizations both pursue the same objective of satisfying customer demand as effectively and efficiently as possible.

The objectives, context and constraints of humanitarian assistance programmes as well as the characteristics of health care goods determine the logistics and supply chain management objectives which need to be achieved in order to enable, support, sustain and complete humanitarian assistance programmes. Excellent logistics management requires linking all logistics activities to the strategic planning of the organization (Schulte, Ch. 1999, 596).

3.1.1 Minimizing safety and security risks

Minimizing safety and security risks for recipients, staff, assets and assistance goods must be the overriding concern in management of humanitarian assistance in general as well as in logistics and supply chain management in particular (UNHCR 2000, 262), even if efficiency is decreased. An overview of the objectives, context and constraints which imply the need for minimizing safety and security risks is presented in table 3.1.

MINIMIZING SAFETY AND SECURITY RISKS	Continuous risk assessments	Minimize numbers of and carefully select staff	Minimize value of stocks, assets and cash	Locate assets and stocks in most secure places	Decentralization of assets and stocks	Maximize safety of staff, assets and goods	Provide emergency care by own means	Decentralization of distribution	Direct deliveries to recipients	Consider alternative routes and modes of transport	Obtain security clearance before any transport	Caution in dealing with authorities	Caution with commercial transactions
Objectives													
Towards donors													
Openness, transparency and accountability			●	●	●				●				
Towards recipient													
Community													
Security of affected population	●							●					
Management objectives													
Security of staff, assets and stocks	●	●	●		●								
Context and constraints													
Related to humanitarian organizations													
Donors													
Accountability, reporting and auditing			●	●	●								
International or global													
International staff		●											
Less developed countries													
Politics / Government													
Potential political instability	●		●		●								
High levels of corruption												●	
Poorly developed legislation and legal security													●
Economy													
Poor transport infrastructure						●							
Limited availability of third party logistics suppliers					●								
Social													
Low level of health care services							●						
Complex political emergencies													
Armed conflict													
Lack or collapse of state authority	●		●		●							●	●
Insecurity and high levels of violence	●	●	●	●	●		●	●		●	●		
Blocked or closed borders										●			
Unpredictable and dynamic conflict	●		●	●	●					●			
Damage to and destruction of infrastructure						●							
Recipients													
Diversion and theft of assistance goods	●		●	●	●				●		●		
Health care goods													
Characteristics													
High value			●	●	●				●				
Deterioration and damage													
Susceptibility to deterioration and damage			●							●			

Table 3.1 Minimizing safety and security risks

The objectives are to reduce the likelihood of risks occurring as well as to reduce the impact in case the risk could not be avoided (Mayhew, B. 2004, 141).

Safety refers to protection from threats from diseases, accidents and natural disasters while security refers to protection from acts of deliberate human violence (Van Brabant, K. 2000, xiii).

A detailed security plan must be developed for every country and sites where humanitarian organizations are active (UNHCR 2000, 326). Acceptance of humanitarian organizations and their assistance programmes by the community (Mayhew, B. 2004, 10) as well as conflict parties is a key element in reducing security risks.

While humanitarian organizations cannot influence the threats they are exposed to they can reduce their vulnerability for example by protecting buildings from intrusion and they can reduce the impact of security incidents, for example by reducing the number of staff as well as the value of goods and assets in a site (Mayhew, B. 2004, 10).

Information of the government, authorities, the local population as well as the conflict parties about the humanitarian organization, their work in general as well as their programmes is another key element of security management (Mayhew, B. 2004, 21). Moreover being well informed about the development of the political and security situation and sharing information with other actors is indispensable for accurate assessments and analyses (Mayhew, B. 2004, 20). The attitude of staff towards the population, employees, authorities and armed forces and their consideration for local customs, traditions and religions (Mayhew, B. 2004, 28) as well as adherence to security measures is one of the most important elements of security management. Staff of humanitarian organizations should not carry any kind of weapons as these are likely to damage their credibility in general as well as efforts to be perceived as neutral and humanitarian (Mayhew, B. 2004, 31).

Damage to and loss of assets and goods will reduce the capacity of humanitarian organizations to provide humanitarian assistance and therefore increase suffering.

The potential political instability, possible collapse of state authority, insecurity, unpredictability of conflicts as well as the constant risk of diversion and theft of assistance goods requires regular assessments of the overall security situation. It allows stopping transport operations and relocating stocks and assets to safer areas if necessary. In order to avoid increasing the risks for recipients, the security situation must be assessed before every delivery of humanitarian assistance goods or provision of services.

Reducing the number of staff carrying out logistics activities reduces the overall risk of staff being harmed. Larger vehicles will require fewer drivers for transporting the same payload and using powered handling equipment in warehouses will reduce the number of staff exposed to conflict related risks.

Staff members must be carefully selected to reduce the risk of being targeted because of their nationality, ethnicity, religious or political affiliations. At the same time the composition of the workforce of a humanitarian organization in terms nationality, ethnicity and religion must reflect the composition of the population to avoid being perceived as biased (Mayhew, B. 2004, 14).

Keeping the value of cash, stocks and assets such as vehicles to the necessary minimum will reduce the extent of losses in case of theft, robbery, looting or conflict related damages. Reducing stock levels, especially of highly sensitive health care goods, also reduces losses in case of deterioration or damage during storage.

The general insecurity and unpredictability of the conflict requires locating assets and stocks in the safest available place which still allows providing the required services.

Humanitarian organizations are accountable to donors, who ultimately pay for replacing damaged goods or higher insurance premiums. They will question any unreasonable security risks taken by humanitarian organizations and be reluctant to provide further funding if the loss of stocks and assets could have been avoided through more cautious management.

In situations where placing assets and stocks in insecure areas is necessary in order to provide the required level of services to humanitarian assistance programmes, the risk of damage or loss can be spread by decentralization. Decentralization will also

reduce the risk of completely disabling logistics services which, besides the financial loss, could seriously affect people in need which suddenly cannot be provided with essential health care goods anymore. The possibility of reducing the risk for humanitarian organizations by outsourcing transport and storage will often be limited by the availability of third party logistics providers and the difficulty of holding them liable for any damages or losses.

The accident risk, which is increased by the poor quality of roads and airports, must be minimized by careful maintenance of means of transport. Damage to stocks by fire, water, high and low temperatures must be prevented by taking precautions and carefully maintaining stores and warehouses.

In the absence of any emergency services, humanitarian organizations must provide assistance to their staff in case of accidents or conflict related injuries by their own means and establish evacuation plans (UNHCR 2000, 328). This will often require establishing reliable communication networks independent of national networks especially for transport through insecure areas.

The movements of recipients through insecure areas to central places where humanitarian assistance goods or services are provided as well as the aggregation of large numbers of people increase their overall risk of being affected by the conflict. The aggregation of people generally has an adverse affect on sanitary conditions and increases the risk of outbreaks of communicable diseases. Besides sick or injured people might be unable to travel to health care facilities and therefore be deprived of medical attention.

Consequently humanitarian organizations must try to decentralize their assistance across the affected area as far as possible.

Direct deliveries to health care facilities, rather than donating goods to national or district authorities for further distribution, will decrease the risk of diversion of theft by criminals, parties to the conflict or authorities. Donors will require assurance from humanitarian organizations, rather than intermediaries they do not know, that assistance goods have actually arrived at assisted health care facilities.

The general insecurity as well as the possibility of borders or front lines being closed requires considering and planning reasonably safe and secure alternative modes of transport and transport routes. Increasing transport time of sensitive health care goods can lead to deterioration and damage.

In order to reduce the risk of theft and diversion, wherever possible, humanitarian organizations must seek approval from authorities or parties to the conflict for every transport operation.

Humanitarian organizations must take care to abide by laws and regulations and not be tempted to pay bribes demanded by authorities which may expose staff to criminal persecution.

Commercial transactions such as purchasing of goods and assets as well as signing contracts for renting warehouses must be carried out with great care as any kind of recourse may be impossible in the absence of law enforcement and judicial systems. Legal advice should be sought before concluding contracts which should be drawn up in great detail. Losses can be reduced by limiting the value of individual contracts as well as avoiding deposits, especially when engaging with unfamiliar business partners.

Consequently goods should only be paid for after receipt and careful inspection and more frequent payments should be agreed upon for rental contracts, since losses can be reduced in case of breach of contract.

3.1.2 Assuring high quality of provided health care goods

The primary objective of humanitarian organizations, to alleviate and reduce suffering, requires high quality health care goods (WHO 1999d, 7). Health care goods of poor quality will use valuable resources but hardly be effective in preventing epidemics, reducing morbidity, mortality and disabilities. An overview of the logistics and supply chain management objectives which need to be fulfilled to ensure provision of high quality health care goods is given in table 3.2.

ASSURING HIGH QUALITY OF HEALTH CARE GOODS	Substitution of shortcomings of national drug legislatior	Global purchasing strategy	Purchase only of high quality health care goods	Protection of goods during transport and storage	Comply with national pharmaceutical legislation	Reduce stock levels as far as possible	Reduce stages of supply chain	Ensure short transport lead times
Objectives								
Towards donors								
Demonstrate concern for people affected by emergencies			●					
Compliance with humanitarian charter and code of conduct			●					
Relevance, effectiveness and (measurable) impact			●					
Towards recipient								
State								
Accountability towards host state and authorities			●					
Compliance with national legislation and regulations					●			
Community								
Prevent epidemics			●					
Reduction of morbidity and mortality			●					
Individuals or health facilities								
Provision of high quality health services			●					
Provision of high quality health care products		●	●					
Prevent and treat medical conditions			●					
Saving and preservation of human lives			●					
Prevent and reduce disabilities			●					
Prevent and alleviate suffering			●					
Management objectives								
Comply with legislation			●					
Comply with code of conduct			●					
Provide at least minimum standards		●	●					
Context and constraints								
Related to humanitarian organizations								
Internal management								
Final user does not chose goods and services			●					
Donors								
Accountability, reporting and auditing			●					
External management								
Competition for funds and professional staff			●					
International or global								
Customs (crossing international borders)					●			
Less developed countries								
Politics / Government								
Inefficient administration	●							
Poor pharmaceutical legislation and state control	●							
Economy								
Limited availability and quality of products	●	●						
High percentage of counterfeit drugs	●							
Environment								
(Sub)tropical climates				●				
Health care goods								
Characteristics								
Sterilized				●		●	●	●
Limited shelf life				●		●	●	●
Deterioration and damage								
Susceptibility to deterioration and damage				●				

Table 3.2 Assuring high quality of health care goods

The non-profit sector lacks the regulatory mechanism of demand and supply where dissatisfied customers can sanction poor quality services by changing suppliers (Badelt (ed.) 2002, 613). Since recipients do not have the possibility to choose the goods they receive and usually do not have an alternative source of health care

services, humanitarian organizations have an ethical obligation to provide health care goods of high quality.

Accountability towards host countries and donors (ECHO 1999, 35), as well as compliance with national legislation in donor and host countries also require providing high quality health care goods.

The high quality of goods must be maintained along the entire supply chain from the manufacturer until final distribution to recipients (WHO 1992c, 32).

In the absence of national drug legislation or effective enforcement by competent national drug regulatory authorities, which would prevent importation as well as domestic production of substandard health care goods (WHO 1996a, 118), humanitarian organizations need to substitute the missing quality assurance system (WHO 2002a, 5).

Testing of each batch of drug products requires sophisticated laboratories, is expensive (Health Action International 1998) and also requires holding batches in quarantine for the duration of testing which in turn increases lead time. Moreover determining the identity of the active ingredient does not prove that the content complies with the required specifications (WHO 1999, 36). An appropriate content of active ingredients does not necessarily prove bioavailability and efficacy of drug products (Dörner, G. (ed.) 1992, 32). Determining the quality of health care goods and their sterility also requires elaborate testing.

The lack of quality assurance measures in the country where humanitarian assistance goods are provided can be substituted by national drug legislation and drug regulatory authorities of sufficiently high quality in another (developed) country. However some countries apply less stringent regulations to manufacturing of drug products intended exclusively for export (Creese, A., N. Gasmann, and M. Mariko 2004, 99).

Another possibility for substitution is conducting visits and inspections by qualified pharmacists from humanitarian organizations. However these are time consuming and also need to be repeated regularly.

In countries where the quality of domestically available health care goods cannot be assured, humanitarian organizations need to purchase in neighbouring countries, in the respective region or even worldwide.

Although not legally binding, the World Health Organization demands that donated drug products must be comply with quality standards in the recipient as well as donor country (WHO 1999a, 8). Since most major international humanitarian organizations maintain head offices in developed countries with strict pharmaceutical legislation, they must purchase high quality health care goods if they want to comply with the WHO guidelines for drug donations.

The nature of many health care goods, such as limited total shelf life and susceptibility to damage by heat, as well as the often (sub)tropical climates of countries in which humanitarian assistance is provided, require particular attention. The high quality of health care goods must be maintained along the entire supply chain by preventing deterioration, damage and destruction during handling, transport and storage.

Since humanitarian organizations must comply with national legislation of countries where humanitarian assistance is provided in general (Mayhew, B. 2004, 22), they must also comply in particular with pharmaceutical legislation where it is in place.

Compliance with national pharmaceutical legislation is of particular importance when importing goods into a country which may require applying for import permits, submitting certificates of origin and certificates of analysis for each batch.

National drug legislation which should ensure quality, safety and efficacy as well as correct information of drug products (WHO 1988, 50) may impose a minimum remaining shelf life upon importation and may even prohibit importation of high quality health care goods because of lack of registration in the country.

Any increase in stock levels will reduce turnover and therefore shorten the remaining shelf life of health care goods. In order to minimize the losses through expiry in stock and ensure a reasonable remaining shelf life upon distribution to the final recipient, especially in global and multi-echelon supply networks, stock levels must be kept low.

Every tier in the supply network reduces shelf life by the average duration of storage and increases the risk of expiry of health care goods before they can be distributed. Therefore any tier of the supply network which is not necessary to provide the required services to final recipient s should be eliminated.

For the same reasons transport lead times must be kept to the necessary minimum, especially if the required environmental conditions, for example room temperature, cannot be maintained during transport.

Avoiding delays at customs by pre-clearing goods will minimize reduction of remaining shelf life and also reduce the time health care goods are exposed to adverse environmental conditions if ports of entry cannot ensure adequate storage.

3.1.3 Simplicity and reduction of complexity

While most commercial organizations try to provide a wide range of products and varieties in order to please as many customers as possible, the objective of humanitarian organizations is to provide essential goods and services effectively and efficiently to as many people in need as possible. An overview of the factors which require simplification and reduction of the complexity of logistics and supply chain management are shown in table 3.3.

Limiting the number and variety of items which need to be managed will increase the overall simplicity and efficiency of supply chain management (Simchi-Levi, D., Ph. Kaminsky, and E. Simchi-Levi 2003, 115), especially during the initial response, and allow to make the best use of limited and unpredictable funding.

The context of less developed commercial markets and national health care systems as well as the need to respect the principles of Primary Health Care also do not warrant providing a large number of different health care goods. Moreover introducing new and sophisticated health care goods will be unsustainable after humanitarian organizations end their assistance to health care facilities.

A limited number of health care goods only will be necessary to cover essential needs and conform to the essential drugs concept (WHO 1977). In countries with generally low levels of health care services and chronic lack of health care goods, health professionals would not be able to make use of a wide variety of (sophisticated) health care goods. Moreover carefully selecting a limited number of essential drug products encourages rational prescription (WHO 1988, 6).

Standardization limits the variety of goods which also facilitates cooperation with other humanitarian organizations and allows different humanitarian organizations to provide health care facilities with the same, or at least similar, health care goods.

The reduction of items as well as the use of prefabricated kits is indispensable in order to respond to emergencies quickly and to limit the complexity of providing health care goods to a large number of health care facilities across a large geographical area.

The lack of logistics professionals also requires limiting the complexity of supply chain management and limiting the number of managed items will greatly facility donor reporting.

SIMPLICITY AND REDUCTION OF COMPLEXITY	Limited number and variety of items	Simplicity of handling and storage	Limit tiers of supply network	Simplicity of information system
Objectives				
Towards donors				
Efficiency	●	●	●	●
Openness, transparency and accountability	●	●	●	●
Towards recipient				
State				
Consideration for national health care system	●			
Giving priority to Primary Health Care	●			
Enable viability and long-term development	●			
Community				
Relevance, cover essential community needs	●			
Individuals or health facilities				
Immediate initial response	●			●
Management objectives				
Coordination with other humanitarian organizations	●			
Context and constraints				
Related to humanitarian organizations				
Internal management				
Provision of essential goods	●			
Standardization	●			
Donors				
Limited resources	●	●	●	●
Unpredictable funding	●	●	●	●
External management				
Coordination among humanitarian organizations	●			
Less developed countries				
Economy				
Limited availability and quality of products	●			
Poor telecommunications infrastructure				●
Social				
Lack of logistics professionals	●		●	●
Low level of health care services	●			
Chronic lack of health care products	●			
Complex political emergencies				
Armed conflict				
Insecurity and high levels of violence		●	●	●
Possibly sudden onset	●	●		●
Disruption of local and domestic economy	●	●		●
Damage to and destruction of infrastructure				●
Recipients				
Large number of wounded civilians	●			
Large number of sick civilians	●			
People in need spread over a wide area	●	●		
Number and location of people unpredictable		●		
Movement of displaced people unpredictable		●		●
Rapidly changing demand (place, type, quantity)		●		●
Immediate need for humanitarian assistance	●	●		●
Health care goods				
Characteristics				
Limited shelf life	●		●	

Table 3.3 Simplicity and reduction of complexity

Limiting the variety of provided assistance goods, especially of items and sizes which can be substituted for each other, will reduce demand variations through risk pooling and therefore facilitate demand forecasting, allow reducing safety stocks and reduce the probability of goods expiring in stock.

Humanitarian organizations could not justify allocating valuable and limited resources for investment in expensive assets such as sophisticated stores and materials handling

equipment. The need to respond to emergencies quickly requires setting up stores quickly, often improvising with readily available means, and does not allow time for lengthy planning and establishing complex structures. As a consequence of the disruption or collapse of local and domestic economies, sophisticated equipment will be unavailable, would require purchase abroad and incur high transport costs.

Expensive assets cannot be fully recovered when humanitarian assistance programmes end and will increase the extent of financial losses in case the assets are damaged or destroyed in the course of the conflict.

Besides demand may quickly shift over large geographical areas and stores and warehouses may quickly become useless by closure of borders and transport routes.

Limited financial as well as human resources also necessitate limiting the tiers in the supply network as far as possible while maintaining the required level of service to recipients. Limiting the number of tiers in the supply network will avoid unnecessary shortening of remaining shelf life and the number of tiers must be kept as low as possible in insecure areas in order reduce the risk of damage and losses. Finally reducing the number of tiers in the supply network reduces demand distortion (Lee, H.L., V. Padmanabhan, and S. Whang 2004, 1883), increases forecasting accuracy and therefore facilitates forecasting and planning (Klaus, P. 2004a, 510). In the context in which humanitarian organizations work, specialists for establishing, operating, using and maintaining complex information systems as well as the required time for planning and implementation are not available. Investment in expensive equipment would also divert valuable funds from assistance which benefits recipients directly and would incur large financial losses in case of theft, damage or destruction in the course of hostilities. The unpredictability of conflicts and rapidly changing demand would incur significant expenses for moving and reinstalling complex information systems.

The unavailability or unreliability of telecommunications infrastructure does not allow real time data exchange and resorting to satellite communications would be prohibitively expensive.

3.1.4 Effectiveness

Logistics and supply chain management is crucial for the effectiveness of humanitarian assistance (Thomas, A. and L.R. Kopczak 2005, 2) which is one of the requirements discussed in chapter 2. An overview of factors which determine the need for effectiveness is presented in table 3.6.

While effectiveness might be taken for granted in commercial logistics and supply chain management, humanitarian organizations will have to overcome several obstacles before assistance goods can be delivered to the health care facilities where they are required. In this context effectiveness means providing the required amount of goods with the required specifications as well as required quality to the requested health care facilities at the requested time.

Effectiveness of logistics and supply chain management will in turn allow effective implementation of humanitarian assistance programmes, which is a key criteria for evaluating and assessing humanitarian organizations (ECHO 1999, 20). Since the primary objective of humanitarian organizations is the reduction and prevention of suffering, effectiveness translates into the extent to which logistics and supply chain management enables implementing and sustaining humanitarian assistance programmes which prevent and reduce suffering.

Unlike most commercial organizations, effectiveness will have priority over efficiency, especially whenever the respective humanitarian organization is the only source of essential health care goods and humanitarian organizations are preoccupied with determining the feasibility of assistance programmes (Perrin, P. 1996, 150). The objective is taking "all possible steps" (The Sphere project 2004, 5) to reach the people with the greatest need rather than providing services efficiently to the maximum number of people. Where recipients rely on humanitarian organizations, which are committed to provide only essential health care goods, as their sole source, any shortages will deprive health professionals of the means to treat people and save lives and can therefore have dire consequences (PAHO 2001, 6). In the context of chronically under-resourced health care systems which is exacerbated by the armed conflict, shortages are prone to arise quickly.

Fulfilling the primary objective of saving and sustaining lives will, especially during the initial emergency response, warrant committing disproportionate resources such as using expensive air transport for small amounts of health care goods or evacuating sick and injured.

Where peripheral health care facilities are not supplied, the few central health care facilities will be quickly overwhelmed with patients seeking treatment (Perrin, P. 1996, 196).

3.1.5 Reliability and consistency

In order to maintain their effectiveness and achieve measurable impacts, humanitarian assistance programmes require reliable and consistent logistics support (Shawkey, P., and C. Hart 2003, 7). The objectives, context and constraints which determine the need for reliable and consistent logistics services are shown in table 3.6.

Many medical conditions require regular administration of drug products over a certain period of time. Interrupting anti-infective treatment courses can be conducive to the development of resistance to drug products and preventing epidemics requires consistent vaccination programmes in order to quickly reach minimum coverage of the affected population. Maintaining Primary Health Care services requires a continuous supply of essential drug products (WHO 1978, 28). The ability to provide consist health services in hospitals depends on the regular and reliable supply of health care goods (Bloch, Y. (ed.) 2001, 118). Providing and installing essential health care equipment (for example autoclaves, operating lamps or diagnostic equipment) implies the obligation to provide operating equipment as well as ensuring maintenance and servicing until health care facilities regain their self-sufficiency.

Shortages of health care goods, which compromise the quality of provided health care services or even cause interruption and suspension of humanitarian assistance programmes, would undermine the credibility of humanitarian organizations towards donors as well as host countries.

The supply network must allow to provide health care facilities regularly under stable conditions as well as when transport routes are disrupted by adverse weather conditions, hostilities or when borders are closed.

While a rapid response may be essential during the initial emergency phase, reliability and consistency is essential in maintaining regular supply of health care goods. Once required stock levels are reached at the assisted health care facilities, the speed of replenishment shipments is of little importance provided stockouts are prevented.

3.1.6 Flexibility and responsiveness

The need for flexible health care services (Hanquet, G. (ed.) 1997, 142) as well as the pervasive uncertainty of the context and of humanitarian assistance programmes demands flexible and responsive logistics services (UNHCR 2000, 262). Some changes are gradual and can be anticipated, at least to some degree, others are sudden and unpredictable. On overview of factors which require flexible and responsive logistics services is shown in table 3.4.

FLEXIBILITY AND RESPONSIVENESS	Flexibility of goods and quantities	Flexibility in delivery	Flexibility of supply network	Flexibility of logistics capacities	Flexibility in mode of transport
Objectives					
Towards donors					
Relevance, effectiveness and (measurable) impact	●	●			
Towards recipient					
State					
Consideration for national health care system	●				
Consider national capacities	●				
Coordination with other humanitarian actors	●	●	●		
Community					
Security of affected population		●			
Reduction of morbidity and mortality	●				
Reaching and assisting the most vulnerable		●			
Balance assistance to different groups		●			
Consider local capacities and prevent dependency	●	●			
Individuals or health facilities					
Prevent and treat medical conditions	●				
Saving and preservation of human lives	●				
Prevent and reduce disabilities	●				
Prevent and alleviate suffering	●				
Management objectives					
Coordination with other humanitarian organizations	●	●	●		
Context and constraints					
Related to humanitarian organizations					
Donors					
Dependency on donations	●				
Unpredictable funding	●				●
External management					
Coordination among humanitarian organizations	●	●	●		
Possibly dependence on other organizations	●	●			
Less developed countries					
Politics / Government					
Potential political instability	●	●			
Economy					
Poor transport infrastructure			●		●
Delays for importation of goods			●		●
Complex political emergencies					
Armed conflict					
Lack or collapse of state authority	●	●	●		
Insecurity and high levels of violence	●	●	●		
Blocked or closed borders			●		●
Restriction, obstruction and denial of access			●	●	●
Possibly trade, transport and communication sanctions			●		●
Possibly sudden onset	●	●	●	●	
Unpredictable and dynamic conflict	●	●	●	●	●
Disruption and collapse of local and domestic economy	●		●		
Damage to and destruction of infrastructure			●		●
Recipients					
People in need spread over a wide area		●	●		
Number and location of people unpredictable	●	●	●	●	
Movement of displaced people unpredictable		●	●		
Rapidly changing demand (place, type, quantity)	●	●	●	●	
Erratic ordering	●				

Table 3.4 Flexibility and responsiveness

Generally, high variability in demand requires responsive and flexible supply networks (Simchi-Levi, D., Ph. Kaminsky, and E. Simchi-Levi 2003, 240). Several factors require flexibility in providing different goods in changing quantities. Demand increases and decreases with the extent and intensity of hostilities and also depends

on the type of weapons and warfare. Displacement, epidemics and deterioration of the nutritional status of the population will increase demand. Changes in standard treatment protocols as well as seasonal diseases increase demand for some items while decreasing demand for others. Finally lack of consistent inventory control policies at health care facilities can lead to erratic demand even though end-user demand is stable.

Even where end-user demand is stable, demand for health care goods will vary with increases and decreases of assistance to individual health care facilities as well as with changes in the number of assisted health care facilities. Despite unchanged needs, changes in funding will determine the kind and extent of assistance humanitarian organizations can afford.

Assistance by humanitarian organizations will also vary with changing capacities of the community and national health services as well as assistance by other humanitarian actors in the same area or even the same health care facility. Demand can also change quickly and unexpectedly with changes in the security situation and access to affected populations.

Even where the kind and quantities of demand remain unchanged, the required place of delivery may change depending on the development of the conflict, changes of access as well movement of displaced populations. Maintaining impartiality and balancing assistance may also require shifting assistance depending on changes of power structures and the political context. Demand may also quickly shift from a damaged or abandoned health care facility to another or away from a health care facility which has restored its self-sufficiency. New humanitarian actors may take over assistance from other humanitarian organizations who may in turn decide to shift their assistance to another place.

Supply network designs will need to be adapted to changes of supply sources as well as the location of assisted health care facilities. Even where both of these remain unchanged, networks will have to adapt to changes of security and access. Paradoxically increasing hostilities will inevitably increase demand while decreasing ease of access (Trintignac, F. (ed.) 1999). Opening and closure of borders as well as transport routes may require setting up new stores and closing others at short notice. Suitable supply networks may need to adjust their capacities significantly in a short period of time.

Flexibility will also be required in the choice of modes of transport. Roads, railways, ports and airports may be inaccessible for security reasons and access may be denied by authorities or as a consequence of sanctions. Authorities and parties to the conflict may also deny overflight and landing rights for aircraft or completely close the air space for civilian aircraft.

Means of transport may be (temporarily) unavailable due to breakdowns and transport infrastructure unusable or impassable due to damage or weather conditions such as landslides and floods. Changes in modes of transport may also be imperative due to lack of funding.

3.1.7 Independence

Logistics services must support the general objective of humanitarian organizations to maintain their independence from parties to the conflict discussed in chapter 2. The factors requiring logistics services to maintain their independence are shown in table 3.5. The provision of assistance by armed forces has contributed to the erosion of the notion of the neutrality of humanitarian assistance (Schneider, M. 2003, 140).

Provision of humanitarian assistance by armed forces confuses recipients, is relatively costly and any association with local, domestic or international armed forces may endanger humanitarian workers (Sondorp, E., and A.B. Zwi 2002, 311). Moreover impartiality of humanitarian organizations is indispensable in gaining access to people in need (VENRO 2003, 16). Consequently armed forces should focus on providing security and protection for the civilian population rather than delivering humanitarian assistance (Sondorp, E., and A.B. Zwi 2002, 311).

INDEPENDENCE	Independence from domestic human resources	Independence from domestic logistics capacities	Independence from domestic suppliers	Independence from domestic communication networks	Independence from domestic financial infrastructure
Objectives					
Towards donors					
Relevance, effectiveness and (measurable) impact		●	●		
Towards recipient					
State					
Neutrality towards conflict parties	●	●			
Community					
Impartiality	●	●			
Individuals or health facilities					
Assure assistance reaches recipients, effectiveness		●			
Provision of high quality health care products			●		
Immediate initial response		●			
Management objectives					
Fulfill its mandate		●			
Comply with code of conduct		●			
Maintaining independence		●			
Security of staff, assets and stocks	●	●			
Context and constraints					
Related to humanitarian organizations					
Internal management					
Impartiality		●			
Less developed country					
Politics / Government					
Potential political instability		●	●	●	●
Poorly developed legislation and legal security		●	●		
Economy					
Poor financial infrastructure					●
Poor transport infrastructure		●			
Limited availability of third party logistics suppliers		●			
Poor telecommunications infrastructure				●	
Limited availability and quality of products			●		
High percentage of counterfeit drugs			●		
Social					
Low level of education	●				
Lack of logistics professionals	●				
Complex political emergencies					
Armed conflict					
Insecurity and high levels of violence	●	●	●	●	●
Restriction, obstruction and denial of access	●	●			
Trade, transport and communication sanctions			●		
Possibly sudden onset	●	●	●		
Unpredictable and dynamic conflict		●	●		
Disruption of local and domestic economy		●	●		
Recipients					
Immediate need for humanitarian assistance	●	●			
Health care goods					
Deterioration and damage					
Susceptibility to deterioration and damage		●			

Table 3.5 Independence

The need for establishing and maintaining effectiveness, regardless of the context and constraints of humanitarian assistance programmes, requires logistics services of humanitarian organizations to avoid dependency on domestically available infrastructure and resources.

Especially in ethnic and religious conflicts, where employing national staff may put them at risk and compromise the impartiality and neutrality of the humanitarian

organization, international staff is necessary especially for transport operations. Specialists such as pilots or transport managers may be unavailable domestically and again require hiring international staff. During the acute emergency phase international staff may be indispensable until qualified national staff can be recruited.

Domestic transport and storage capacities may be of limited quality, may have insufficient capacities, may not be (immediately) available at all and may lack the necessary expertise for handling health care goods.

Commercial suppliers which are associated with any of the conflict parties as well as services provided by governments, authorities, national or foreign armed forces could compromise the neutrality and impartiality of humanitarian organizations. Where humanitarian organizations compete for limited resources or commercial suppliers control the market, rates or conditions may be unreasonable and more expensive than own account transport.

Commercial services can suddenly cease if the security situation deteriorates and commercial carriers may be unable to operate in conflict areas while conflict parties may still be obliged to allow humanitarian organizations access.

Where legal security and law enforcement is lacking, outsourcing logistics services can incur significant risks as there may be no recourse in case of damage or theft.

Health care goods available in domestic markets may be limited in range and quality or be counterfeit. Specialized goods, such as medical kits, will be unavailable and domestic commerce can be disrupted by trade sanctions. Complete dependency on domestic suppliers of health care goods carries the risk of disrupting supply of assisted health care facilities in case of shortages and stockouts.

Moreover several humanitarian organizations and other actors may be competing for the same (limited) domestic resources. Lack of legal security carries the risk of financial losses if contracts cannot be enforced and commerce may be suspended altogether in case the security situation deteriorates.

Domestic communication infrastructure is often poorly developed or damaged in the course of hostilities. Maintaining communications, which are indispensable for the security of staff and means of transport, may require installation of independent radio, telephone or satellite communication networks for voice and data transmission.

Where the financial infrastructure is poor or has collapsed, humanitarian organizations may have to ensure regular supply of cash or use financial services of other countries for paying suppliers with foreign accounts.

3.1.8 Rapid initial response

When a new complex political emergency arises in places where the communities and authorities do not have the capacity to cope with the increased needs of affected people immediately, humanitarian organizations must ensure a rapid initial response (Ockwell, R. 1994, 418). A rapid response by humanitarian organizations requires rapid provision of logistics services (PAHO 2001, 131). An overview of factors which determine the need for a rapid initial response is presented in table 3.6. The same considerations apply to hostilities which arise in a previously fairly stable and peaceful area in a crisis region as well as to sudden changes in demand.

Especially in crises which attract significant media attention, donors will require swift interventions and demand humanitarian organizations to demonstrate that their assistance programmes have an impact on the plight of the affected populations very quickly.

Providing assistance to wounded people as well as interventions to preempt epidemics is required to be effective and timely interventions can make a difference between life and death (PAHO 2001, 5).

The chronic lack of health care goods and the low quality of health care services in general implies that states and communities have few resources to cover the needs during the initial emergency phase and allow humanitarian organizations some time for responding. The World Health Organization estimates that one third of the world's population and half of the population in poor areas lacks access to even essential drug products (WHO 1998, 3).

However once assistance to health care facilities has started and stocks of all essential health care goods are established, quick replenishment is not adding any value as long as there is no danger of shortages and stockouts. Especially in protracted conflicts maintaining systems of responding to any demand rapidly will be unsustainable because of their high costs.

3.1.9 Efficiency

While effectiveness must be given priority over efficiency, the best possible use must be made of funds for which several humanitarian organizations are competing. Among several alternatives which can achieve the same results and impact, the most cost-effective alternative must be chosen (ODI 2006, 44). An overview of factors which determine the need for efficiency is presented in table 3.6.

While economic systems value all factors in financial terms (Badelt (ed.) 2002, 132) and efficiency in for-profit organizations can be defined as ratio between financial inputs and financial outputs, non-profit organizations do not seek financial gains or profits. Moreover social and humanitarian benefits of humanitarian assistance programmes cannot be measured in financial terms (Hallam, A. 1998, 85). Since the primary objective of humanitarian organizations is reducing suffering, efficiency can be understood as the extent to which suffering is reduced (output) with a certain amount of resources (input). Consequently logistics and supply chain efficiency can be understood as the reduction of suffering which is achieved with a certain amount of humanitarian assistance goods and the resources required along the entire supply chain for making them available to the end-user.

The careful use of funds is also an obligation towards donors (ECHO 2003, 2). Donors may be willing to fund effective but inefficient operations for a short period of time during the initial emergency response, such as deploying field hospitals or using expensive airlifts. As soon as the survival of the affected populations is no longer at risk and especially in protracted complex political emergencies, humanitarian organizations will have to resort to more efficient humanitarian assistance strategies.

Since humanitarian organizations can never satisfy all the needs, any decrease in efficiency will deprive some people in need of humanitarian assistance (Stockton, N. 2001, 11).

Increasing efficiency is an important means for humanitarian organizations to compete for limited funding as donors will want to maximize the impact of their funds. Once humanitarian organizations have been allocated funds, they will have to complete the programmes according to the proposed time schedule and within budget in order to be eligible for further funding.

3.1.10 Accountability

In practical terms, humanitarian organizations are primarily accountable towards their donors (Koivusalo, M., and E. Ollila 1996, 101). Since most humanitarian organizations have only small financial reserves, donors will usually advance funds for implementation of humanitarian assistance programmes. Donors will demand to be kept informed of the final use of resources and need to satisfy themselves that their donations were used correctly and their contributions were useful (PAHO 2001, 160).

Funding may be suspended if humanitarian organizations cannot account in detail how funds were used. Humanitarian organizations may be accountable after predetermined periods of time through intermediate reports or at least upon completion of the programme. Unsatisfactory accounting will disqualify them from continuation of funding or eligibility for applying for future funding. An overview of factors which determine the need for accountability of logistics services are presented in table 3.6.

Humanitarian organizations must not only account for the funds they have received but are also accountable towards donors for the humanitarian assistance programmes which they have carried out (Perrin, P. 2002, 22). Humanitarian organizations will have to provide detailed reports on their programmes, number and kind of recipients as well as the impact their programmes had on the assisted population.

Logistics services will have to justify and account for all purchases of goods and services, account for overall logistics costs and provide detailed reports on kind, quantity and places of distribution of humanitarian assistance goods.

Humanitarian organizations are also accountable towards the host countries and authorities which may have granted access and various privileges only on the condition that the population is assisted effectively. When suspicion arises among the public, conflict parties or recipients that humanitarian assistance goods have been mismanaged, logistics managers must be able to provide detailed reports on distributions (PAHO 2001, 159).

Although recipients rarely have the possibility to choose among offered humanitarian assistance and to sanction the poor quality of provided services (Hilhorst, D. 2001, 15), one of the principles of the Code of conduct states that humanitarian organizations hold themselves accountable to those they seek to assist (The Sphere Project 2004, 320). Moreover assessments by independent auditors as well as media reports will point out shortcomings of assistance programmes and put pressure on humanitarian organizations to provide high quality services.

In order to provide accurate information and allow detailed auditing, logistics services need to keep meticulous records of all their purchases (tenders, purchasing contracts etc.), details of kinds, quantities, dates and places of distributions as well as recipients and regularly prepare reports (European Commission 1998d, 49).

Details on recipients as well as the date and place of distribution must also be recorded and provided for any goods which are subject to sanctions in order to prove that the civilian population rather than conflict parties benefited directly from the assistance.

3.1.11 Summary of logistics and supply chain management objectives

The logistics and supply chain management objectives derived above are summarized in table 3.6 which shows the relation between objectives, context and constraints of humanitarian organizations as well as characteristics of health care goods with the respective logistics and supply chain management objectives.

The individual logistics and supply chain management objectives which follow from the objectives, context and constraints of humanitarian organizations can be summarized in ten objectives: minimizing safety and security risks, assuring high quality of provided health care goods, simplicity and reduction of complexity, effectiveness, reliability and consistency, flexibility and responsiveness, independence, rapid initial response, efficiency and accountability.

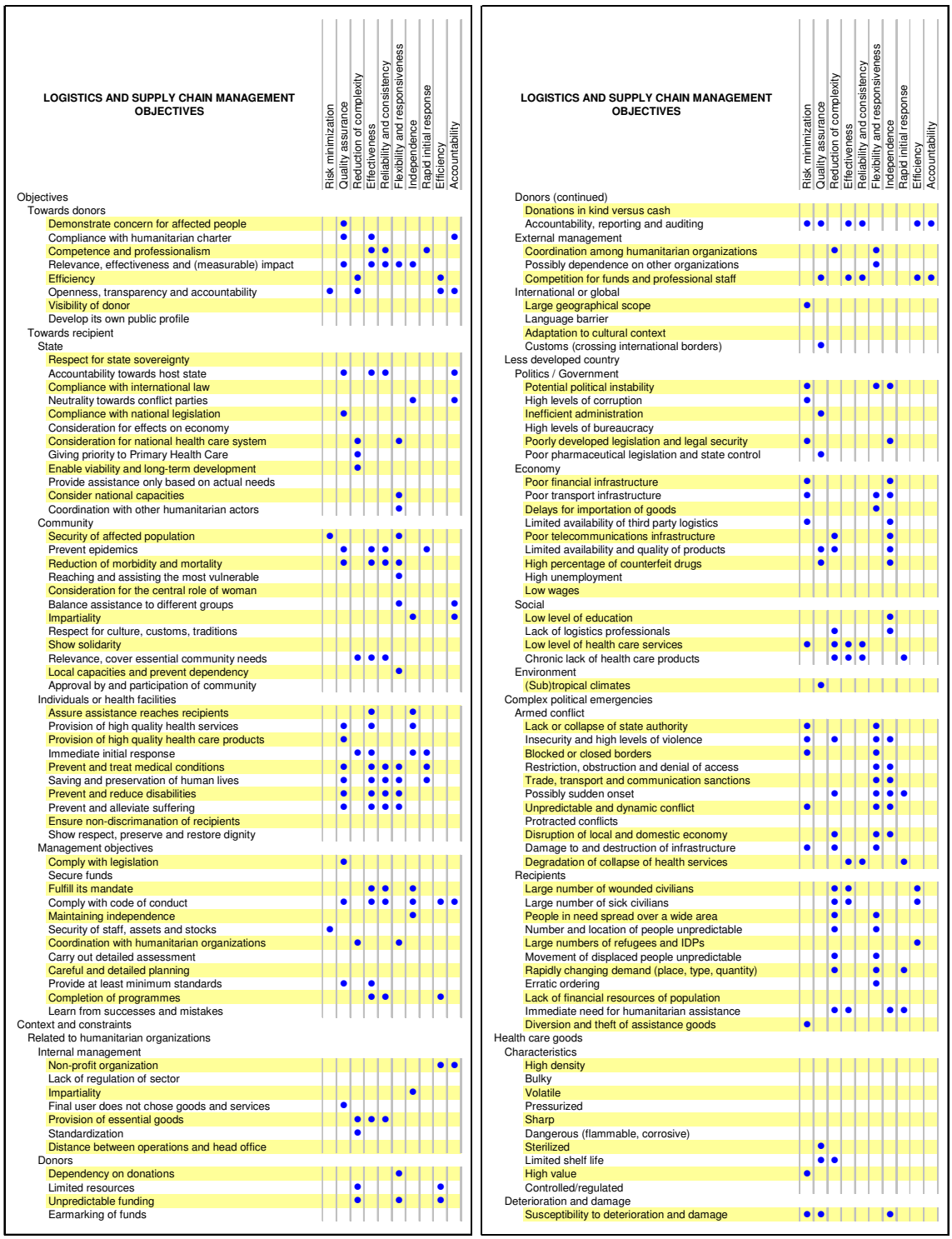

Table 3.6 Summary of logistics and supply chain management objectives

3.2 Trade-offs between objectives

The logistics and supply chain management objectives can be grouped into objectives related to risk, customer service and cost.

Significant security risks for recipients as well as humanitarian organizations are inevitable in the context of complex political emergencies. Consideration of the trade-off between benefits of caring for injured people and the risk for the people providing care themselves (Coupland, R., Å Molde, and J. Navein 2001, 2) equally applies to staff providing support services.

To a certain degree the risks incurred by humanitarian organizations and by recipients are related. Centralization of services in safe areas and places will decrease the risk for humanitarian organizations but increase the risk for recipients and delay medical treatment since recipients need to travel to benefit from provided services (Coupland, R., Å Molde, and J. Navein 2001, 2). Independence, neutrality and impartiality will generally reduce the risk of threats and attacks from parties to the conflict.

Customer service provided to recipients, which ultimately reduces suffering, will increase with higher quality of health care goods, increased effectiveness, higher reliability and consistency of services, faster initial response and higher flexibility and responsiveness of services.

Greater efficiency as well as reduction of complexity and simplicity will reduce costs.

Accountability cannot be traded off as it is an external constraint which is a prerequisite for obtaining funds and therefore indispensable for humanitarian organizations to operate. Higher accountability towards recipients and donors requires increasing the quality of provided services but at the same time demands reducing costs and increasing efficiency.

While logistics managers will try to achieve all objectives, compromises will have to be found at all levels.

Several trade-offs between safety and security risk for humanitarian organizations as well as services provided to health care programmes and recipients need to be considered (figure 3.1).

The insecurity caused by the conflict can delay or even make health care programmes impossible. An immediate initial response to an emergency as well as changes of logistics services limits time available for analysing the context and situation and assessing safety and security risks. Once health care programmes have been implemented, humanitarian organizations must decide on a case by case basis whether to take the associated risks and provide services or postpone or even cancel humanitarian assistance programmes. For the same reasons humanitarian organizations may have to interrupt their services and therefore trade off incurring security risks and ensuring reliability and consistency of services.

A trade-off must be made between safety and security risk as well as efficiency and complexity and reducing risks by securing warehouses, taking detours for transport, travelling in convoys or using air transport increases costs. A trade-off must also be made between using mainly manual handling which requires more staff and increases their risk and the use of powered handling equipment which increases cost and complexity.

Operating independently from parties to the conflict, authorities, other humanitarian organizations, commercial organizations and the military may reduce the risk of being

seen as partial in the conflict but at the same time increases logistics cost as resources cannot be shared.

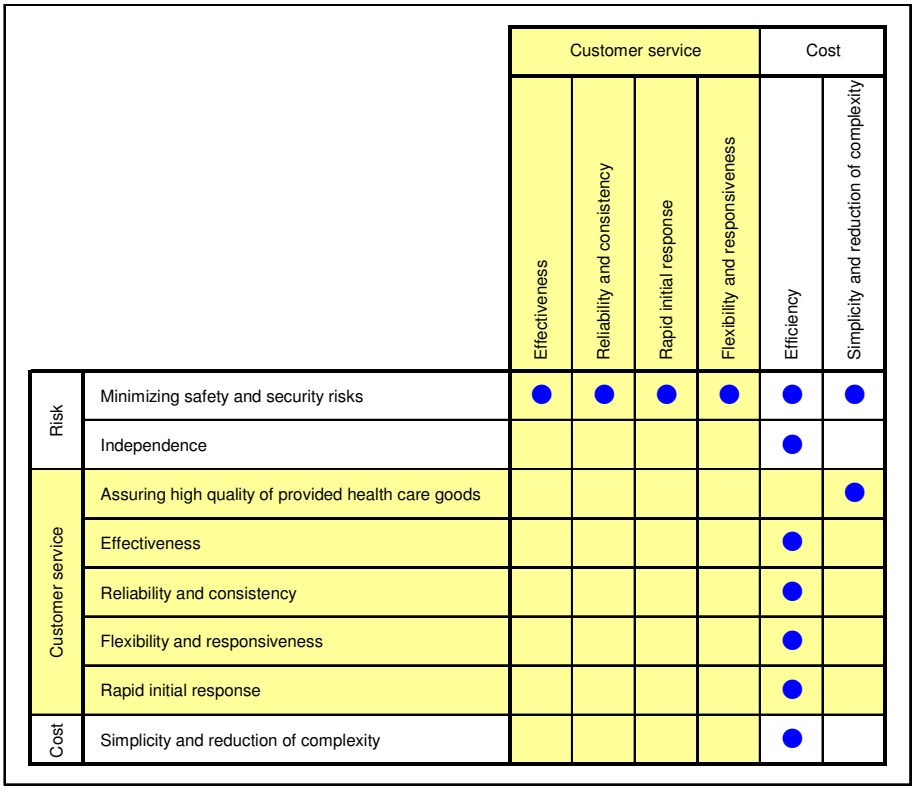

Figure 3.1 Trade-offs between objectives

Finally the trade-off between service and cost must be considered. Higher quality of health care goods, especially devices and equipment, are often more complex and use more sophisticated technology which increases the complexity of required logistics services for installation, training, maintenance and servicing.

An increase in effectiveness may increase cost and decrease efficiency when recipients are assisted in areas which are more difficult to reach and supply. An increase of the number of recipients will require covering a larger geographical area which incurs higher costs than concentrating on a smaller area.

Like in commercial logistics and supply chain management, greater reliability and consistency of services incur higher costs. Higher stock levels are required, alternative modes and routes of transport must be planned for and possible more stores are needed closer to customers. Likewise a trade-off between flexibility and responsiveness as well as efficiency must be made (Chopra, S., and P. Meindl 2004, 59). Similarly a rapid initial response is more expensive than a slower response as it requires using more expensive means of transport and limits the possibility of using third party logistics suppliers, especially in the crisis area, since their identification and contracting takes time.

The objectives of logistics and supply chain management can be summarized as enabling the greatest possible reduction of suffering at the lowest possible cost (Thomas, A. and L.R. Kopczak 2005, 1) while incurring the lowest possible safety and security risks for staff, assets and humanitarian assistance goods. The trade-offs between the three groups of logistics and supply chain management can be summarized as presented in figure 3.2.

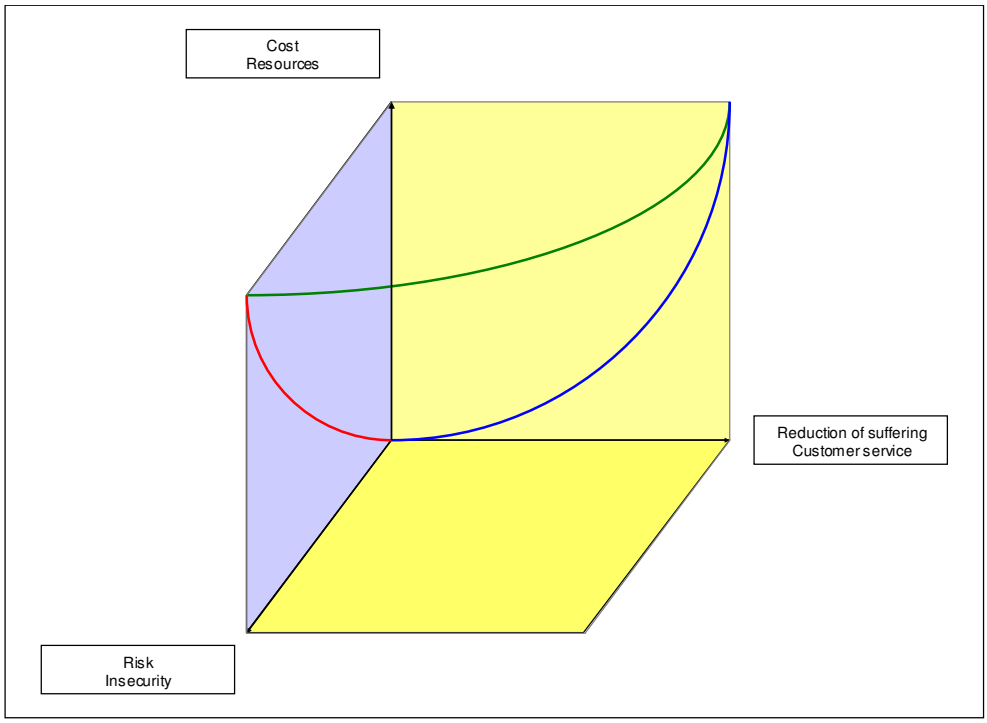

Figure 3.2 Summary of trade-offs between objectives

In general reducing suffering or increasing customer service as well as greater insecurity and higher safety and security risks will increase overall logistics costs. At a given amount of available resources, safety and security risks and customer service are inversely related. At any given level of insecurity and risks increasing services will increase costs and at a given level of service any increase of risks will also increase costs.

3.3 Framework dimensions

The two dimensions of Thorn's framework will be further explored, modified and extended before adding the aspects of time, distance and criticality.

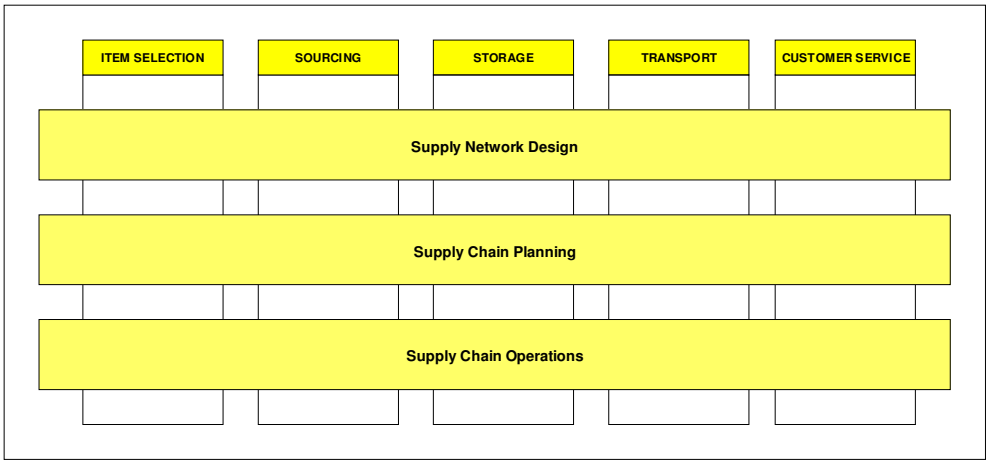

Figure 3.3 Adaptation of Thorn's framework

Because the characteristics of items have important implication for logistics and supply chain management, item selection is separated from sourcing and included as a separated logistics process.

The process of production is removed as humanitarian organizations generally are not concerned with manufacturing and production.

The process of distribution is differentiated into storage and transport, which may be carried out a several tiers of the supply network, and the process of providing customer service is maintained to derive the framework presented in figure 3.3.

3.3.1 Management levels

Thorn distinguishes between strategic, tactical and operational supply chain planning levels (Thorn, J. 2002, 22). Various aspects of these levels are summarized in table 3.7.

Management Level	Strategic	Tactical	Operational
Customer scope	Health assistance strategy	Assistance programme	Health care facility
Supply Chain Management	Supply network design (Configuration)	Supply chain planning (Coordination)	Supply chain operations (Execution)
Aspect	Static structure (Space)	Dynamic flow (Time)	Individual transactions (Goods and information)
Management scope	Resources	Capacities	Activities
Time horizon	Long-term (more than 2 years)	Mid-term (0.5 to 2 years)	Short-term (less than 0.5 years)
Resource allocation	Long-term	Mid-term	Short-term
Uncertainty and risk	High	Medium	Low
Cost of change	High	Medium	Low
Geographic scope	Worldwide and regional	National	Local
Decision making	Head office (global / centrally)	Mid-level management (national level)	Logistics staff (local / decentrally)

Table 3.7 Framework management levels

The strategic planning provides direction and control for tactical planning which in turn determines operational plans (Lambert, R.S., and J.R. Stock 1993, 717).

Strategic supply chain management planning must support the overall objectives and strategy of the respective humanitarian organization in general and the assistance strategy for health care programmes in particular. This corresponds to the requirement in commercial logistics and supply chain management to link the logistics strategy to the corporate strategy (Gattorna, J. (ed.) 1990, 23).

Tactical management focuses on supporting specific assistance programmes in a country or region which supports a number of health care facilities while operational plans are directed towards serving a specific health care facility.

Supply chain management can be divided into the three hierarchical levels of supply chain design, supply chain planning and supply chain operations (Chopra, S., and P. Meindl 2004, 7). However the complexity of a multitude of suppliers and customers is more accurately reflected in the term supply network (Christopher, M. 1998, 18). For the strategic level the term supply chain configuration and for the operational level supply chain execution have also been proposed (Walther, J., and M. Bund (ed.) 2001, 17).

Supply chain design or configuration is concerned with decisions on the structure of the supply network such as location of suppliers and warehouse facilities or the type of information systems to be utilized (Chopra, S., and P. Meindl 2004, 7).

At the tactical level supply chain planning is carried out within the constraints and structure of the network design (Chopra, S., and P. Meindl 2004, 7).

Supply chain operations are concerned with individual customer orders and daily operations which are carried out within the confines of supply chain planning decisions (Chopra, S., and P. Meindl 2004, 7).

While all levels of logistics planning are concerned with the flow of goods, strategic management deals primarily with the static structure of supply networks (Thorn, J. 2002, 23). Tactical supply chain management is primarily concerned with managing and optimizing dynamic flows of information and goods within and through a given supply network while operational management is concerned with individual transactions.

Strategic management is concerned with determining and mobilizing required resources while optimizing processes and allocating capacities within the confines of a given structure is the task of tactical management. Operational management finally is concerned with carrying out individual activities.

Strategic management decides on the long-term allocation of resources (Chopra, S., and P. Meindl 2004, 7), tactical management is concerned with capacities of flows and operational management with day-to-day activities.

Strategic management decisions have a long-term effect on the organization and concern decisions which are valid for more than two years (Thorn, J. 2002, 22). These are further realized in mid-term tactical decisions which are taken for the next six months to two years while operational decisions concern the short-term future of less than six months.

The allocation and commitment of financial, human and technical resources corresponds to the time horizon (Gattorna, J. 1990, 45).

The uncertainty of future developments and therefore the risk that decisions will be wrong or require revision naturally increases with the time horizon.

The cost of changes at short notice increases with the time horizon as long-term decisions usually require significant investment and allocation of resources (Chopra, S., and P. Meindl 2004, 7).

Strategic decisions apply to the entire organization and therefore concern logistics management worldwide. Tactical decisions depend on the context and constraints of humanitarian assistance programmes and may therefore differ from country to country where humanitarian assistance is provided while operational decisions apply to the local level.

The level of decision making corresponds to the geographic area which is affected. Strategic decisions which affect the entire organization worldwide are taken centrally. Tactical decisions are taken by mid-level management at national level while operational decisions are the responsibility of staff at the respective site (European Commission 1998d, 27).

3.3.2 Logistics processes

According to the above criteria various strategic, tactical and operational issues of the logistics processes can be determined as presented in table 3.8.

At the strategic level criteria for including items in the standard item catalogue are determined which apply to all health care programmes of the humanitarian organization. According to the respective health care programmes in a country, selected items are included in the programme standard list from which customers in turn select items which are required for their health care facility.

Logistics processes	Strategic issues	Tactical issues	Operational issues
Item selection	Logistical requirements Variety control Standard item catalogue	Programme standard list Kits versus individual items	Order placement
Sourcing	Supplier qualification Dual versus multiple sourcing Centralized vs. decentralized purchasing Width of supplier base	Tender format Supplier selection Purchasing contracts	Purchasing transactions
Storage	Storage facility location Emergency preparedness Ownership of facilities Site and facility selection	Demand forecasting Inventory control policy Stock positioning of items Emergency stock positioning	Stock replenishment Preventing deterioration Warehouse operations
Transport	Physical distribution channels Contingency plan Mode of transport Ownership of transport means	Distribution systems Selection of mode of transport Ownership of transport capacity Selection of means of transport	Routing and scheduling Protection of goods Reverse logistics
Customer service	Customer service policy Customer service elements Collaborative planning	Customer service plan	Order processing Customer service measurement

Table 3.8 Logistics processes

The sourcing strategy defines general criteria for supplier qualification (Thorn, J. 2002, 23), the geographic scope as well as the overall number of suppliers. The format and participants for tenders as well as the type of purchasing contracts are tactical decisions which are realized in operational purchasing transactions.

The location and ownership of storage facilities require significant investment and therefore a long-term strategic decision (Klose, A., and P. Stähly 2004, 482). The positioning of individual items and the inventory control policy are taken at a tactical level (Thorn, J. 2002, 17) and determined according to the needs and development of assistance programmes. Operational decisions are taken to replenish stocks and for the day-to-day management of warehouses.

The selection of physical distribution channels as well as mode of transport affect the facility network and must therefore be made at a strategic level. Ownership of transport means requires significant resources for acquisition as well as maintenance and therefore requires a long-term strategy. The selection of distribution systems as well as selecting among different available modes of transport depends on the context and constraints of the country where humanitarian assistance is provided while routing and scheduling are operational decisions.

The worldwide customer service policy is translated into customer service plans for each health assistance programme while order processing is an operational activity.

3.3.3 Aspects of time, distance and criticality

The framework of Thorn can be extended by adding the aspects of time, distance and criticality.

Strategies for humanitarian assistance and interventions differ from the contingency phase before emergencies, the emergency phase, the rehabilitation and reconstruction phase as well as the development phase (OECD 1997, 10). As logistics managers provide services to humanitarian assistance programmes, they must also adapt priorities and strategies to these phases (Oloruntoba, R., and R. Gray 2003, 8). Moreover the context and constraints also differ between these phases.

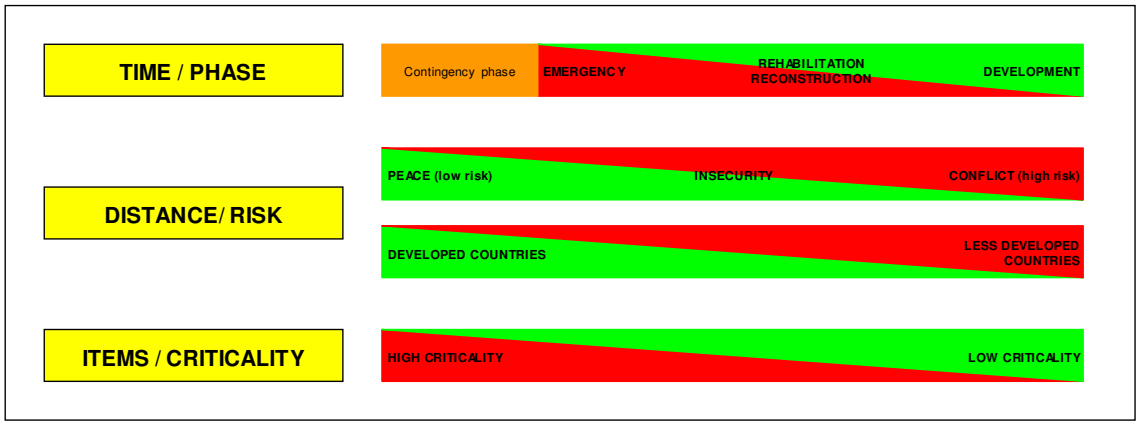

Figure 3.4 Aspects of time, distance and criticality

However, rather than a smooth transition of these phases, most complex political emergencies are characterized by a shift between different phases for many years before the conflict is resolved (Ballance, S. (ed.) 2005, 2). The conflict intensity in different parts of the same country or crisis may differ significantly at the same time. Moreover in some case emergency assistance and measures to start rehabilitation might be carried out simultaneously (Perrin, P. 1996, 365). In any case humanitarian assistance programmes during the emergency phase should be provided in ways which will support rehabilitation and sustainable development (UN General Assembly Resolution 46/182, 1991).

Humanitarian organizations may not intervene immediately after the onset of an emergency because they do not have access, are not able to obtain funding or because domestic sources can cope with the emergency. Consequently the emergency phase for the humanitarian organizations starts at the time a decision is taken by the respective humanitarian organization to provide humanitarian assistance.

The second aspect refers to the distance to the crisis area and the associated safety and security risks. The context and constraints for logistics and supply chain management will change as humanitarian organizations approach the conflict area for two reasons. First, humanitarian assistance is mostly provided in less developed countries with poor infrastructure while for many humanitarian assistance goods supply networks commence in developed countries.

Secondly the insecurity and therefore the risk increases as the distance to the conflict area decreases. Supply networks commence in countries at peace and end at health care facilities in or at least near to the conflict area. The level of insecurity can increase gradually or abruptly, for example when crossing borders or a front line and within a country the security situation can differ widely between areas.

The physical distance between peaceful and conflict areas can be fairly short for example when a conflict area near to an international border is supplied from a neighbouring country which is at peace. However the physical distance can also be large where an entire geographical region is affected by the conflict and countries bordering on the conflict area are not entirely peaceful either.

The third aspect is related to the provided goods themselves. Logistics and supply chain management strategies will also depend on the criticality of humanitarian assistance goods. Highly critical items have to be of high quality, will have to be managed with a high degree of reliability, high service levels and require expediting in case of low stock levels or stockouts in any case.

Items are highly critical (Bowersox, D.J., and D.J. Closs 1996, 300) if they are life saving and a stockout could have detrimental consequences for patients and even lead to preventable deaths. For example replacement parts for autoclaves which are indispensable for any kind of surgery (Bloch, Y. (ed.) 2001, 121) or drug products used during resuscitation. Another criterion for criticality is the lack of available substitutes.

3.3.4 Framework overview

The two dimensions of management and planning levels as well as the logistics processes of Thorn's framework are extended by the three aspects of of time, distance and criticality.

The transition between the management levels is continuous and may even overlap for some issues. Logistics activities are carried out consecutively, although goods will usually require storage and distribution at several tiers of the supply network.

However the aspects of time, distance and criticality are independent of each other and each of them has to be seen in the context with the two other dimensions separately. Consequently the framework might lead to conflicting conclusions for the three different aspects and require finding a compromise. For example the strategic framework for distribution of highly critical items will suggest using the fastest mode of transport during the emergency phase while the high risk inside the conflict area suggests using the safest mode which may be road transport.

4 SUPPLY NETWORK DESIGN

The following chapter will explore the strategic aspects of the logistics processes presented in table 3.8 and develop a strategy for each of them by considering the context and constraints of humanitarian organizations as well as the logistics and supply chain management objectives developed earlier.

4.1 Item selection

Humanitarian organizations must carefully select appropriate assistance goods and consider the specifications of goods which they distribute and donate.

Health professionals need to determine the kind and scope of humanitarian assistance their organization wants to provide and decide on the range, required functions, performance and effectiveness of health care goods which are necessary for implementing programmes.

However the selection of health care goods requires consideration of a number of logistical issues which are presented in figure 4.1.

This chapter will consider general requirements for health care goods since they must be selected in advance and must therefore be suited to any context and programme. At this stage the selection is independent of specific products or manufacturers.

4.1.1 Logistical requirements for health care goods

Several requirements apply to all categories of health care goods.

The need for high quality results directly from the logistics and supply chain management objectives discussed in chapter 3. The World Health Organization guidelines on drug donations prohibits double standards in quality and by implication the quality of other health care goods must also comply with the quality standards of the humanitarian organizations' head office country.

The large geographical scope of international humanitarian assistance and the uncertainty over the country where humanitarian assistance goods will be provided requires that goods are accepted worldwide. Although no worldwide standards have been established, drug products must comply with internationally recognized pharmacopoeial standards and health care goods which conform, for example, to the standards of the European Union are likely to be accepted by recipient countries worldwide.

The large geographical scope as well as the necessary flexibility to distribute humanitarian assistance worldwide, implies the need for multilingual product information. The Guidelines for Drug Donations require that "All drugs should be labelled in a language that is easily understood by health professionals in the recipient country" (WHO 1999a, 9). For example The Interagency Emergency Health Kit is furnished with information in English, French and Spanish (WHO 2006a, 52).

Humanitarian assistance goods should be acceptable by a wide range of different cultures, traditions and religions. As far as possible symbols with religious connotations, even if these are not intended, should be avoided.

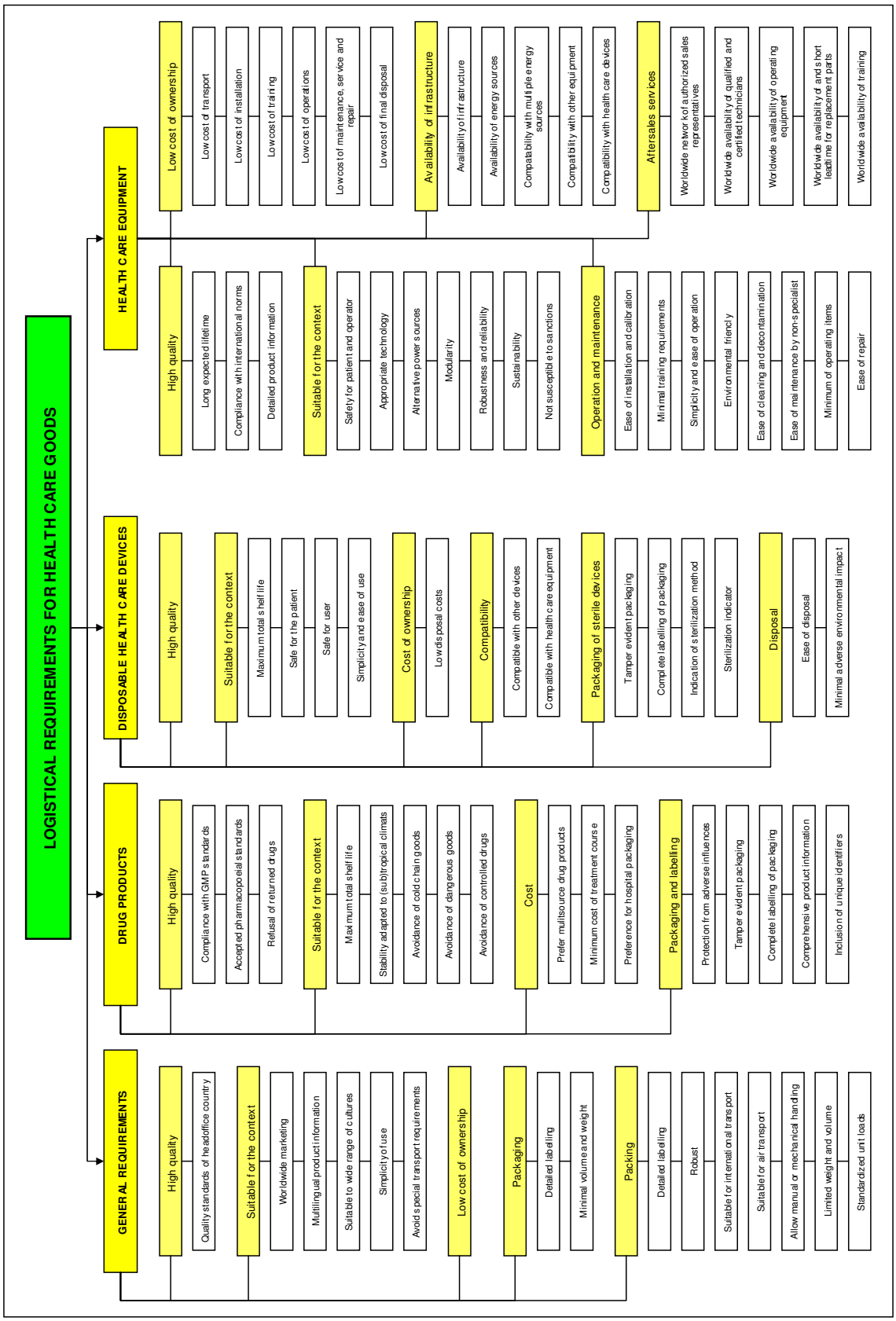

Figure 4.1 Logistical requirements for health care goods

In the context of countries with low levels of education, a low level of health care services and lack of health care professionals, all health care goods should be sustainable, simple to use or require minimal training.

For the sake of simplicity, flexibility and reduction of transport costs, wherever possible transport and storage of humanitarian assistance goods should not be subject to special requirements such as certain temperature ranges (PAHO 1983, 12) or special packing for dangerous goods.

For selection of humanitarian assistance goods the total cost of ownership throughout their expected lifetime should be considered since humanitarian organizations are accountable for all expenses and the use of provided goods should be sustainable. The cost of ownership include purchasing price, transport and insurance, import tax and customs, installation, training, cleaning, disinfection, maintenance, service, operations, refunds from warranties as well as final disposal. Electrical equipment may require providing expensive power generation.

The cost incurred by health care facilities after humanitarian assistance programmes are ended should also be considered. Packing adds cost but can also save cost by reducing the likelihood of damage during transport.

Despite the higher purchasing price and the need for disinfection and sterilization equipment, the overall cost of using and reconditioning reusable goods such as reusable syringes, catheters or surgical linen may be lower than for certain disposable goods. Reusable goods do not require regular purchase and transportation, reduce storage costs along the supply chain and reduce the costs associated with shortages and stockouts.

However reusable goods carry the risk of inappropriate cleaning and disinfection which can transmit infectious diseases (Quick, J.D. (ed.) 1997, 154). On the other hand the use of disposable goods incurs higher costs for appropriate waste disposal.

All packaging must be furnished with detailed labels, especially since recipients are likely not to be familiar with the product and may heavily rely on the indicated information such as the type of product, specifications, country of origin, manufacturing date, required storage conditions as well as any possible hazards (Kaur, M., and S. Hall 2001, 6).

In order to minimize transport and storage costs, the volume and weight of health care goods should be as low as possible. For example pouches with solutions require less volume than bottles and plastic packaging (ampoules, infusions) is much lighter than glass packaging. As far as possible drug products should be provided in the largest available quantity units and hospital packs (PAHO 2001, 150) which have far smaller volumes than blister packaging of individual tablets or capsules. Powders, such as some drug products or x-ray developer, which can be reconstituted with water, significantly reduce weight as well as volume.

Apart from its main function of protecting goods, packing also allows identification of goods and facilitates handling, storage and transport (Koether, R. (ed.) 2004, 361). As far as possible, packing should protect goods against pilfering and theft.

Labels should identify the goods they contain and indicate the weight and volume of each package, handling instructions as well as special transport and storage requirements. In order to avoid delays labels should be printed in languages understood in the recipient country and should withstand damage due to rough handling and adverse climatic conditions (PAHO 1983, 11).

Packing must be robust and suitable for the context of recipient countries and possible distribution in remote areas. Lack of suitable storage facilities

(PAHO 1983, 11) as well as transport by carrying or by pack-animals may expose humanitarian assistance goods to adverse weather conditions. Especially health care equipment may require additional protective packing.

Humanitarian assistance goods must be packed in accordance with international shipping regulations (PAHO 2001, 150) and withstand multiple and possibly rough handling and transport during international transport.

Where dangerous goods cannot be substituted and avoided, packing must comply with the IATA Dangerous Goods Regulations, which may limit the maximum packing quantities and require special packing, to maximize flexibility in selection of modes of transport.

As sophisticated and powered materials handling equipment is often not available in the recipient country and at receiving health care facilities, all packing should be designed for manual or mechanical handling. For example the packing specifications for the Interagency Emergency Health Kit require suppliers to attach handles to each carton (WHO 2006a, 51).

As far as possible, the weight and volume of individual parcels as well as master cartons should allow handling by a single person, movement in narrow stores as well as transport in small aircraft, boats and vehicles as well as on carts or pack-animals. Equipment such as hospital furniture, operating tables or x-ray equipment might have to be packed in parts and be assembled at its destination.

The size of master cartons should be standardized at least for the internal supply chain to ensure that they fit standard storage equipment and allow maximizing utilization of standard unit loads. Selection of standard sizes for unit loads such as pallets is also a strategic decision as storage and materials handling equipment throughout the supply network must be adapted to them.

Master cartons can be grouped into larger units to increase handling efficiency (Bowersox, D.J., and D.J. Closs 1996, 437). Unitization increases protection and security of goods and facilitates materials handling and documentation (Rushton, A., J. Oxley, and Ph. Croucher 2000, 98).

The selection of unit loads requires considering the possibilities and constraints of transportation and storage throughout the entire supply network. For international distribution equipment used for unitization of master cartons must be cheap as their return is not economical. Pallets can be moved horizontally with inexpensive materials handling equipment and can be used as storage equipment in the receiving store.

For international shipments of large quantities of health care goods the use of standard shipping containers can be considered. However the availability of heavy materials handling equipment at the receiving store must be ensured.

Some special considerations are necessary for the selection of drug products. Medical criteria for selection of drug products are high efficacy, bioavailability, safety of application and minimizing adverse effects.

Although worldwide accepted and required standards for the quality of drug products have not been established, production according to Good Manufacturing Practices (GMP) is generally considered as a standard requirement (WHO 1998a, 6). However no international standards for GMP certification have been established and the reliability of GMP certification therefore depends on the standards established by national authorities in the country of manufacture as well as the quality of the certification procedure (WHO 1992c, 24).

Many countries have established their own pharmacopoeial standards to which drug products must comply. However, the standards of the British, European as well as International Pharmacopoeia (WHO 2003a) are generally accepted worldwide.

Compliance with the highest internationally available standards minimizes the risk that importation of drug products is refused and causes a shortage at the assisted health care facility.

Any drug products that have already been issued to patients and then returned to a pharmacy must not be donated as their quality cannot be assured (WHO 1999a, 8). Besides in countries, where the use of returned drug products is prohibited, their donation and use by humanitarian organizations would create a double standard.

All drug products imported into a country must conform to the requirements of national pharmaceutical regulations. The Guidelines for the use of the WHO Certification Scheme on the Quality of Pharmaceutical Products moving in International Commerce recommends that the importing country obtains assurance from the exporting country that the drug product is authorized for marketing in the exporting country (WHO 1995a, 32). However this scheme has no legal status and is a non-binding guideline (Creese, A., N. Gasmann, and M. Mariko 2004, 96).

Since humanitarian assistance goods are usually distributed through international supply networks with multiple echelons and through several safety stocks, wherever alternatives are available, drug products with the longest possible total shelf life should be chosen. For example powders which are reconstituted before application are often more stable and therefore have a longer total shelf life than liquid preparations. This will ensure that drug products still have a remaining shelf life of at least one year upon arrival in the recipient country (WHO 1999a, 8) and avoid expiry during transport or storage. Longer total shelf lives allow using cheaper but slower modes of transport during international shipping.

The World Health Organization recommends that drug products which are intended for marketing in (sub)tropical countries or in the global market are suitable for marketing under the conditions of the hottest and most humid climatic zone IV (WHO 1996a, 70).

Wherever possible, cold chain products and dangerous goods with their special and expensive storage and transport requirements should be avoided and substituted. Drug products which are subject to United Nations conventions on narcotic drugs and psychotropic substances should also be avoided and substituted as exportation as well as importation may be delayed or even rejected.

While humanitarian organizations must make the best use of funds, patient safety must never be compromised by poor quality health care products (Kaur, M., and S. Hall 2001, 6).

Multisource ("generic") drug products, which are generally cheaper than single source (branded) drug products, should be preferred ((PAHO 1983, 50) provided that they comply with the required quality standards (WHO 1996a, 115).

For selecting drug products the costs of total treatments rather than unit costs should be compared (WHO 1998a, 5) and the cheaper alternative should be selected, wherever different dosage forms with the same utility for the patient are available. For example tablets are usually less expensive than capsules (WHO 1998a, 5).

In general hospital packs will be far cheaper than individual blister packaging and are also less attractive for theft and resale.

The quality of packaging which offers protection against humidity, radiation, oxygen, contamination and physical damage is of particular importance for drug products and must comply with pharmacopoeial requirements.

In order to reduce the risk of pilfering and adulteration, drug products should be packaged in tamper-evident containers which are fitted with devices which irreversibly reveal, whether the container has been opened (The Stationery Office 1999, 14).

For drug products, which often cannot be distinguished from each other visually, labelling of the primary as well as secondary packaging are critically important. All active ingredients must be identified by their International Nonproprietary Names (INN) which is also understandable for health professionals who are not familiar with the trade names. Labels must also indicate dosage form, strength, batch number, quantity of the packaging, manufacturing and expiry date, pharmacopoeial standard, manufacturer, country of origin as well as required storage conditions.

Vaccines may be furnished with vaccine vial monitors which irreversible change their colour after exposure to a predetermined amount of cumulative heat and warn health workers against application of spoiled doses.

Package inserts are an essential supplement to labels and inform patients and health professionals about indications, contraindications, precautions, mode of administration, duration of use, adverse effects as well as measures in case of an overdose (WHO 1997, 36).

The application of unique identifiers, such as printing names or logos of the humanitarian organization on primary and secondary packaging, can contribute to preventing theft and counterfeiting of drug products but may delay distribution and increase cost (Quick, J.D. (ed.) 1997, 262).

Quality requirements for disposable health care devices are not as clearly standardized and codified as for health care goods (Quick, J.D. (ed.) 1997, 151). For example the European Union has established stringent requirements and standards for medical devices (European Commission 1993). The trade-off between price and quality has to be considered while ensuring that the devices are safe and allow providing high quality treatment and care.

Like drug products, disposable health care devices, including all sterile goods, should be manufactured and packaged with a maximum total shelf life. The use and application of health care devices must be safe for the patient as well as the user (Cheng, M. 2003, 4).

Health care devices should be as simple as possible and the required skills for their use adapted to the lower level of education and skills often found in the context of humanitarian assistance.

The cost of collection and safe final disposal must be included in the cost of ownership.

Health care devices must be compatible with other devices as well as with equipment provided by humanitarian organizations. For example syringes must fit cannulas, catheters, drains and tubing must be compatible with connectors and receptacles and x-ray films must fit x-ray cassettes. Incompatibility of two devices may render both of them useless and cause a shortage or require stocking a larger number of items.

Sterile packaging must be tamper evident to avoid accidental use of contaminated health care devices.

Labelling must indicate the batch number, sterilization date, sterilization method as well as expiry date (use by date). Each package should be furnished with a sterilization

indicator which irreversible changes colour upon completion of sterilization by heat, ethylene oxide or irradiation (Kaur, M., and S. Hall 2001, 7).

In the absence of public waste management systems, the disposal of used health care devices should be possible with simple means such as incineration or burial and have minimal adverse environmental impact.

Medical kits should be simple to use, adapted to the context of humanitarian assistance and designed by health professionals for a specific purpose and task. Standardized kits, which are used in different situations, will not cover all needs in a specific situation but should be designed to cover the majority of needs in the majority of situations. As far as possible, individual health care goods should not be included in several different kits to avoid redundancy when different kits are combined. Kits should be composed of standard items to ensure compatibility and allow continuation of assistance programmes without having to change health care goods to which health professionals have adapted.

The logistical requirements for drug products as well as disposable health care devices discussed above also apply to the items contained in medical kits. Health care goods requiring special handling such as cold chain items, dangerous goods or controlled drugs should not be included with other items in the same kit. The expiry dates of individual items should not differ too much since otherwise eventually kits will have to be opened to replace items with the shorter remaining shelf lives.

Labelling of the outer packing must indicate the weight and volume of each parcel and indicate the quantities and expiry dates of each item contained in the kit as well as the storage and handling requirements for the kit as a whole.

Health professionals need to select health care equipment which is essential and considers the level of training in the countries where humanitarian assistance is provided (Kaur, M. et al. 2005, 181).

Health care equipment should have a long expected life time and comply with the respective national and international safety and performance standards (Kaur, M., and S. Hall 2001, 6) in order to minimize the probability that importation is refused.

Comprehensive and detailed multilingual product information, operating instructions, technical operating and service manuals, replacement part catalogues (Heimann, P., A. Issakov, S.Y. Kwankam (ed.) 2000,17) and diagrams as well as training manuals are particularly important since qualified technicians may not be available at the receiving health care facility.

Use of health care equipment must be as safe as possible for patients as well as operators (Skeet, M., and D. Fear 1995, 2) and should not pose electrical hazards or danger of fire or explosion.

The use of appropriate technology, which is adapted to the context of less developed countries, for health care equipment is one of the principles of Primary Health Care (WHO 1978, 27). Wherever possible manual, mechanical and hydraulic equipment should be preferred and electronics and integrated circuits should be avoided.

In order to avoid dependency on unreliable power supply, health care equipment should be able to run on different energy sources (Kaur, M., and S. Hall 2001, 8). For example autoclaves should be designed to run on electricity, gas, liquid or solid fuels and refrigerators should have the possibility of running on liquid fuel or gas as well as electricity.

Electric equipment should be able to operate, at least temporarily, on rechargeable batteries to allow operations during power failure or in health care facilities where mains power is unreliable or only available during certain times during the day.

A modular design of health care equipment allows upgrading equipment and replacing defective modules without having to purchase an entirely new piece of equipment.

Health care equipment must be adapted to (sub)tropical conditions and should be resilient against high temperatures, humidity, corrosion and dust (Heimann, P., A. Issakov, S.Y. Kwankam (ed.) 2000,18). It should be simple and robust (Quick, J.D. (ed.) 1997, 151), endure repeated disinfection or sterilization and be resilient against inappropriate operations due to lack of professional training as well as rough handling and neglected maintenance.

Since health care equipment is usually handed over to the health care facilities upon arrival or after humanitarian organizations close their programmes, its operation and maintenance should be sustainable. Operating equipment, accessories, replacement parts as well as repair and maintenance services should be affordable and available domestically (Kaur, M. et al. 2005, 56). In Sub-Saharan Africa up to 70% of health care equipment lies idle because of inappropriate use, lack of training or lack of technical support (Heimann, P., A. Issakov, S.Y. Kwankam (ed.) 2000,10).

Health care equipment and components should not be potentially subject to sanctions which can delay or even prevent import into the country where humanitarian assistance is provided.

Health care equipment should be easy to install, commission and calibrate by a general technician or health care professional but not require a specialist trained by the manufacturer.

Operation, maintenance and servicing of health care equipment should require a minimum of training of health care professionals as well as health care technicians and be simple and easy to use (Kaur, M., and S. Hall 2001, 5). Meters, gauges and displays etc. should indicate technical units of measure which are commonly used in the country receiving humanitarian assistance goods. For example Fahrenheit or degree Celsius on a thermometer, mmHg or kPa on a sphygmomanometer, mmol/l or mg/dl for diagnostic equipment or pressure units on suction machines and autoclaves. Indication of several units on parallel scales or the possibility to switch between units on electronic equipment allows use worldwide.

Health care equipment should cause as little pollution as possible, for example gallium has replaced the highly toxic mercury in thermometers. Health care equipment should be easy to dispose of and not contain any components or materials which pose an environmental hazard which require return to the manufacturer or specialists for final disposal.

Health care equipment should be easy to clean, disinfect and sterilize by simple means such as steam rather than expensive chemicals or special gases.

Health care equipment should be easy to maintain (Kaur, M. et al. 2005, 49) and repair either by health care professionals or by general technicians without specialist knowledge by following instructions in a detailed maintenance manual. Unused health care equipment decreases quality of care and wastes scarce resources (Skeet, M., and D. Fear 1995, 1).

Operating health care equipment should require a minimum of expendable operating equipment such as disposable devices, electrodes, recording paper, reagents or filters

(Heimann, P., A. Issakov, S.Y. Kwankam (ed.) 2000, 18). For example the cost for disposable test strips or cuvettes may far exceed the equipment cost over its life time.

The trade-off between cheap and low quality health care goods which require frequent repairs and replacement and higher price but longer life time need to be considered (Kaur, M., and S. Hall 2001, 7). On the other it is not cost-effective to donate high quality instruments if they are not looked after carefully (Kaur, M., and S. Hall 2001, 7) or likely to be diverted.

Transport costs, which may be considerable for international transport, need to be added to the overall costs. Wherever possible, heavy and bulky equipment, such as operating tables or x-ray machines should be packed and shipped in parts which can easily be assembled by non-specialists. Where surface transport is not possible for security reasons, large aircraft, which may be needed for transporting heavy and bulky equipment, are expensive to operate and sufficiently long and stable runways may be unavailable near the intended destination.

Other costs which are incurred over the life time of equipment such as for installation, licensing, training, operations, maintenance, service, repair as well as decommissioning and disposal also need to be considered (Kaur, M. et al. 2005, 54).

Infrastructure requirements and the likelihood of their availability in recipient health care facilities also need to be considered. Health care equipment may require reliable water and power sources (Kaur, M., and S. Hall 2001, 8), significant space, special construction (radiation protection in x-ray rooms, support beams for operating lamps), flat floors (mobile equipment). Sophisticated anaesthesia equipment requires reliable sources of oxygen, compressed air and possibly nitrous oxide. Installation of autoclaves requires facilities for cleaning, packing and storing sterilized materials and the installation of a dark room is indispensable for operating diagnostic x-ray equipment.

Availability as well as capacity of electric power supply networks or local power generation must be considered for electrical equipment (Heimann, P., A. Issakov, S.Y. Kwankam (ed.) 2000, 1). Equipment should be easily adaptable to different voltages and resilient to power fluctuations and sudden surges. Electric plugs must fit sockets or be easy to exchange. If other energy sources are used availability of fuels such as gas or kerosene must be ensured.

Different pieces of health care equipment must be compatible with each other as well as with any health care devices which are used during operations (Kaur, M., and S. Hall 2001, 6). For example sterilization drums must fit into autoclaves, receptacles must fit suction machines and x-ray cassettes must fit x-ray machines.

For sophisticated health care equipment, such as diagnostic imaging devices or anaesthesia machines, which require installation, commissioning, maintenance, service and repair by a specialist technician trained by the manufacturer, an international service network through authorized distributors and representatives is required. Health care equipment which cannot be serviced locally and requires hiring a specialist from abroad or sending equipment abroad might be more expensive than purchasing a more expensive piece of equipment (WHO 1992b, 13).

Proof of regular maintenance may be a precondition for obtaining and renewing licences for operating health care equipment such as x-ray equipment.

Operating equipment and replacement parts should be available with reasonable short lead times domestically as well to ensure sustainability after handing over equipment to assisted health care facilities.

4.1.2 Variety control and reduction

In the year 2,000 an estimated one and a half million different medical devices were available in the global market (Cheng, M. 2003, V). The need to control and reduce the range and variety of provided health care goods follows from the objective of simplicity and reduction of complexity. The number of items used in an organization tends to gradually increase unless active measures are taken to control variety (Jessop, D., and A. Morrison 1994, 48).

A wider range than necessary increases purchasing and storage costs (Audit Commission 1996, 12) as well as the cost for quality assurance measures. Moreover providing a wide range and high variety contradicts the requirement of sustainability of health care services.

Providing larger quantities of a smaller number of items reduces purchasing costs and increases the efficiency of overall logistics and supply chain management.

Measures for variety control and reduction (Lonergan, E. 2003, 92) intend to reduce the number of health care goods to an optimum which allow balancing the needs of humanitarian assistance programmes with the costs for managing large numbers of goods along the entire supply chain. Substituting a standard item for a variety of similar items, models or products allows benefiting from risk pooling (Simchi-Levi, D., Ph. Kaminsky, and E. Simchi-Levi 2003, 45), increase forecasting accuracy and reduce safety stock levels without reducing service levels.

The reliable provision of a limited number of health care goods is more beneficial to recipients than the unreliable supply of a wider range (Simmonds, St., P. Vaughan, and S. W. Gunn (ed.) 1986, 222).

Several measures are available for controlling and reducing the variety of health care goods (see figure 4.2).

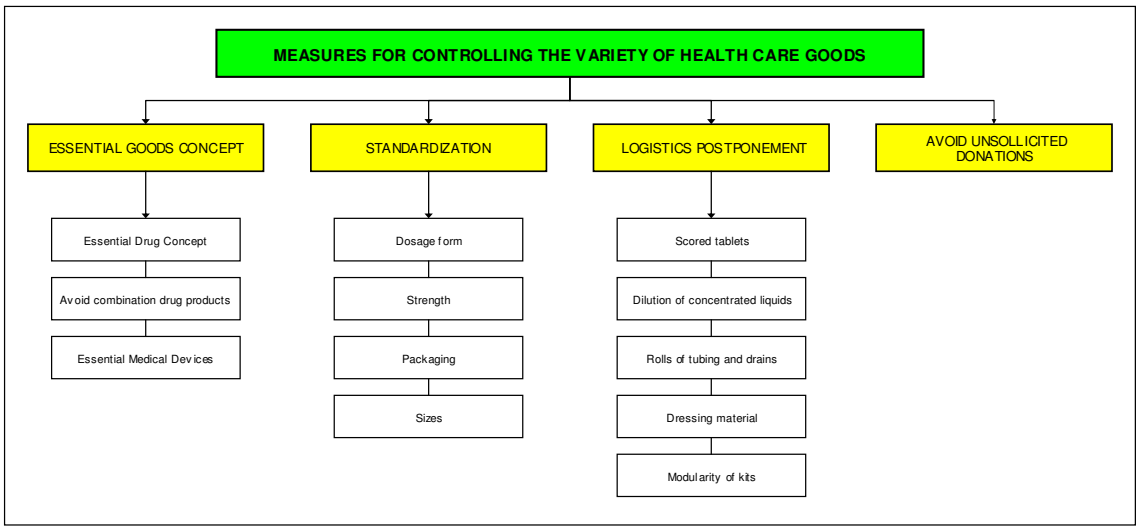

Figure 4.2 Measures for controlling the variety of health care goods

The international drug directory lists nearly 4,500 different active ingredients and more than 50,000 proprietary names of drug products from worldwide 17,000 pharmaceutical manufacturers (Index Nominum 2004). The World Health Organization has listed around 8,000 International Nonproprietary Names of pharmaceutical substances (WHO 2002). More than two thirds of drug products on the world market are duplicates or minor variations which offer no therapeutic advantage or are non-essential (Quick, J.D. (ed.) 1997, 122).

The Essential Drug Concept established by the World Health Organizations in 1977 (WHO 1998, vii) and an important principle of the Primary Health Care concept (WHO 1978, 28) is widely accepted and is an important element of many national drug policies in less developed countries. The core list of the WHO Model List (WHO 2005a) contains only around 300 effective, safe and cost-effective active ingredients which cover the health care needs of the majority of the population and all needs of a basic health care system. The World Health Organization explicitly recommends that non-profit organizations should develop essential drug lists (WHO 1999d, 7). Adherence to the essential drug concept is included as a key indicator (The Sphere Project 2004, 266) for assessing standards of clinical services. Supply chain management is most efficient if the number of provided drug products is limited (Quick, J.D. (ed.) 1997, 8). Selecting items from the WHO essential drug list increases the probability that the drug products are also included in national essential drug programmes.

The formulation of drugs as single compounds (WHO 1998a, 5) reduces the number of drug products since different drug products, which are also used for other treatments, can be administered together rather than having to manage additional combination drug products.

The same principles of the Essential Drug Concept can be applied to disposable health care devices as well as health care equipment (WHO 2003, 18).

Standardization is one way of reducing the number of health care goods (Audit Commission 1996, 12) which have to be handled by logistics services without compromising the quality of medical treatment, and therefore reducing variety. An estimated 12,000 manufacturers offer 750,000 different brands and models of health care equipment (Kaur, M. et al. 2005, 9).

Where several different dosage forms (for example tablets, capsules or syrups) are suitable for treating a medical condition with the same efficacy, one dosage form should be selected as a standard. For drug products where similar strengths can be used interchangeably (for example Metronidazole tablets 200 mg or 250 mg), one strength should be chosen as a standard.

A standard packaging size should be selected for drug products which are available in different quantities. Many solid dosage forms are available in blister packaging or hospital packs and liquid dosage forms as unit-dose ampoules or multi-dose vials.

Although the concept of selecting essential goods is usually limited to drug products, it is equally important for expendable goods and health care equipment which account for around 80% of all health care goods (Quick, J.D. (ed.) 1997, 151).

From the large variety of different sizes of disposable health care devices for example cannulas, bandages, tubes, drains, gloves or x-ray films a selection must be made which allows covering all essential needs.

For disposable health care devices which can be made from different materials, for example rubber or silicone catheters, a selection of one material should be made.

From the host of different models of health care equipment with a multitude of features, humanitarian organizations must select only the most essential pieces of equipment. Standardization of health care equipment also allows to reduce the number of accessories, operating and replacement parts which need to be provided, reduces the number of suppliers (Lenel, A. et al. 2005, 25) as well as the overall cost of ownership (Kaur, M. et al. 2005, 55).

In the case of diagnostic imaging equipment the World Health Organization has established recommendations for standard specifications which are adapted to less

developed countries and are suitable for humanitarian assistance, even though they are not formally accepted or compulsory standards. The World Health Imaging System for Radiography (WHIS-RAD) is designed for Primary Health Care and allows making 95% of all x-ray examinations with simply equipment at low cost (WHO 1995, 2).

Another means of reducing variety is logistics postponement. It allows the end-user to carry out the final configuration of some generic health care goods according to the required specifications (Gattorna, J. 1998, 82) and therefore to reduce the number of different health care goods which logistics services need to provide.

The World Health Organization recommends the use of scored tablets, which can be broken to obtain a convenient paediatric dose, when precise dosage is not mandatory (WHO 1998a, 5).

Different concentrations of disinfectants which are required for different applications (for example surfaces, surgical instruments, fabric) can be produced at receiving health care facilities by diluting a generic concentrate with water.

Some drains and tubing can be provided in long rolls and cut to the required length by the end-user before application.

Some dressing materials such as compresses are available in a large variety of sizes or combination of different materials (for example cotton and gauze). Providing generic products in large rolls or sheets allows end-users to configure the final product to their specifications and practices by cutting, folding and combining materials.

The use of modules allows configuring kits by combining different types and quantities of modules according to the level of health care and needs of the end-users at the supplying store rather than preparing a large number of different kits to suit all possible needs. The part standardization allows reducing stock levels through risk pooling and benefit from economies of scale from purchasing larger quantities of a smaller number of items (Simchi-Levi, D., Ph. Kaminsky, and E. Simchi-Levi 2003, 218).

Unsolicited donations of any health care goods must be avoided, among others, because neither recipients nor humanitarian organizations have control over specifications. Unsolicited donations usually contain a great variety of health care goods and drug products in different strengths (WHO 1999a, 4) which are time-consuming to sort and difficult to manage.

4.1.3 Standard item catalogue

The standardization process results in establishing a standard item catalogue (Burt, D.N., D.W. Dobler, and St.L. Starling 2003, 257) which systematically lists all selected health care goods and indicates their specifications. All items must be identified by international nonproprietary (generic) names rather than proprietary (trade) names and especially drug products must be indicated with their International Nonproprietary Name (WHO 1999c, 12). Specific products or manufacturers are not indicated, except for specific health care equipment where only a single product can fulfill all necessary requirements. Operating equipment, accessories and essential replacement parts should be indicated for each piece of health care equipment.

The standard item catalogue is an indispensable information resource for recipients, humanitarian workers as well as logisticians. The standard item catalogue should also provide logistical information such as the weight, volume, packing dimensions for bulky items and price for each item as well as required transport and storage conditions or restrictions on importation.

The standard item catalogue must be comprehensive and allow covering all basic health care needs at all levels of care which the humanitarian organization intends to serve.

Management of standard items can be facilitated by assigning distinct codes to each item which allow identifying items faster and classifying them in distinct groups. Item codes are also convenient for arranging stock and sorting documents.

4.1.4 Item selection strategy

Irrespective of the complex political emergency and the humanitarian assistance programme the following principles can be applied to selection of humanitarian assistance goods (see figure 4.3).

In order to minimize the complexity of logistics services and allow a quick response, only pre-packed kits should be provided during the initial emergency response. Although kits will not cover all needs, they will allow to provide the great majority of essential humanitarian assistance goods effectively and efficiently (Hanquet, G. (ed.) 1997, 137). In a transition phase, individual items can be provided to complement the contents of kits. Finally, following a detailed needs assessment, analysis of demand data and as soon as the supply network is well established, individual standard items can be provided.

While humanitarian assistance goods must be limited to items to cover immediate survival needs (PAHO 2001, 131), rehabilitation and development of health care facilities will require providing health care goods which are adapted to domestic and local standards, practices and traditions. The standardization of humanitarian assistance goods is indispensable for a rapid and effective emergency response. However it is unlikely that standard health care equipment will match equipment available in health care facilities and therefore to some degree contradicts the need to adjust to local and domestic standards.

During the emergency phase drug products will be limited to the Essential Drugs concept and the standard item catalogue. However during the transition to rehabilitation and development a larger variety of drug products which are included in the national drug register of the country receiving assistance can be provided.

Until health professionals have made sure that health care facilities have the knowledge, organization, facilities and resources to safely clean, disinfect and sterilize health care devices and equipment, only disposable goods should be provided, although they may be more expensive and require transport of larger volumes.

The nearer assisted health care facilities are to the centre of the conflict area, the greater the insecurity and therefore the more difficult logistics and supply chain management becomes. Consequently the need to reduce the complexity of all aspects of logistics and supply management increases with the level of insecurity.

As collecting detailed information on demand from health care facilities in the conflict area is difficult, pre-packed kits should be preferred while health care facilities in more secure areas can be supplied with individual items. In conflict areas health care facilities will focus on emergency services and saving lives and therefore require a smaller variety of health care goods than health care facilities in more secure areas where a larger variety of medical conditions will be treated. For the same reason supplied goods should be essential, highly standardized and have a low degree of variety. Since health care facilities in conflict areas are likely to work under difficult conditions, lacking staff, sterilization facilities and perhaps energy supply, disposable rather than reusable health care devices should be preferred.

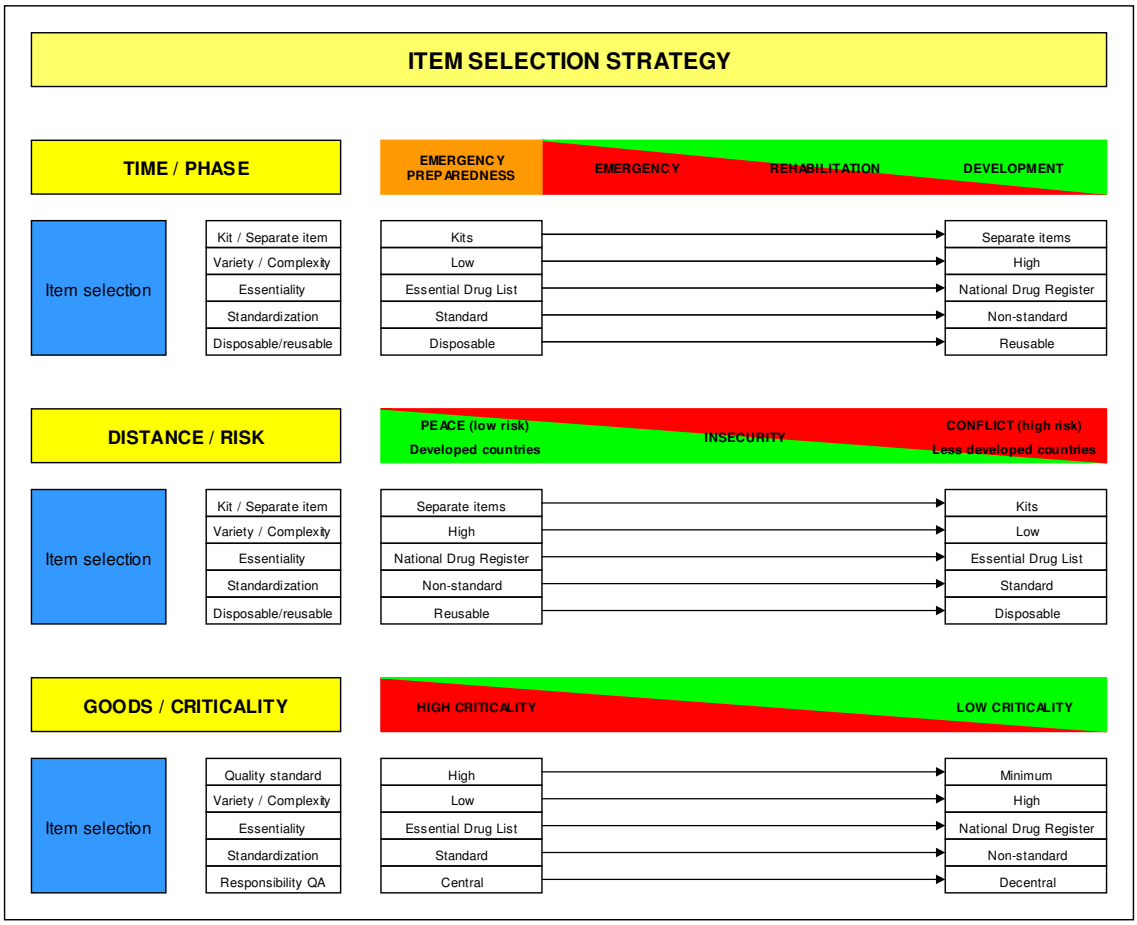

Figure 4.3 Item selection strategy

The importance of quality assurance naturally increases with the criticality of items. While quality is important for all health care goods, the potential adverse effects of poor quality of anaesthetics or suture material are far higher than for example for bandages or hospital furniture. The variety of health care goods should be low for critical items in order to concentrate limited resources to the quality assurance of a small number of items. The more critical quality assurance is, the more central (upstream) the responsibility for selection should be placed where the required skills are more likely to be available.

Critical items must comply with the standards defined by humanitarian organizations in order to ensure effectiveness and safety while strict standards are less important for non-critical items. For the same reason critical drug products should be part of the Essential Drug List while less critical drug products only need to comply with national drug legislation.

4.2 Sourcing

Sourcing includes identifying, qualifying and selecting suitable suppliers as well as purchasing goods and services. The overriding concern of humanitarian organizations must be to provide health care goods of high quality while considering costs and making the best use of funding. A further important concern is to ensure consistent availability, including during emergencies.

4.2.1 Supplier qualification

The general requirements which all suppliers have to comply with are strongly determined by the quality assurance policy of the humanitarian organization as well as donor requirements and require strategic considerations.

Any potential supplier has to comply with national drug legislation and prove that he has obtained a valid license from the national drug regulatory authorities, which must regularly inspect the manufacturing facilities and issue reports on their findings (WHO 1988, 52).

Manufacturers must prove compliance of their manufacturing processes with internationally accepted pharmacopoeial standards such as the European or International Pharmacopoeia.

All aspects of production management of health care goods such as sourcing of raw materials, buildings, equipment, staff, organization as well as manufacturing processes must conform to the Good Manufacturing Practices (GMP) defined by the World Health Organization (WHO 1992c, 80).

Importers of drug products must prove compliance with the provisions of the WHO Certification Scheme on the Quality of Pharmaceutical Products moving in International Commerce (WHO 1996a, 155) which ensures that manufacturers adhere to GMP procedures. However such certificates are only as reliable as the issuing agency (WHO 1988, 53).

Any supplier must be a financially sound and economically viable company (Kaur, M. et al. 2005, 179).

Humanitarian organizations must take a strategic decision whether, or in which countries, the licensing by national drug regulatory authorities satisfies their quality standards or supplier registration requires additional inspections by their own pharmacists.

Humanitarian organizations must also decide whether they support local production for example of infusions, oxygen or drug products for external application.

Donors might impose conditions on humanitarian organizations for funding their programmes and require that suppliers and their goods comply with defined quality standards (ECHO 2003, 14).

Favouring or restricting purchase to primary international or domestic sources (manufacturers) has the advantage of lower prices and increases confidence in the origin and quality of health care products. However humanitarian organizations will have to manage transport to the countries receiving humanitarian assistance for manufacturers which do not have domestic sales representatives.

Secondary sources such as sales agents, importers, distributors, wholesalers, government agencies or other humanitarian organizations have the advantage of having stocks available in the country where humanitarian assistance is provided. However secondary sources may not examine the quality of health care products they sell carefully (Quick, J.D. (ed.) 1997, 241).

In any case purchasers must have confidence in the origin of health care products, must purchase from reliable sources (WHO 1988, 52) and in general direct purchase from known manufacturers rather than through intermediaries is recommended (WHO 1998a, 6).

If health care goods are purchased through sales agents, purchasers must ensure that they are authorized by the manufacturer. Although multinational manufacturers

headquartered in developed countries generally produce health care goods of high quality, they may manufacture in less developed countries with less developed pharmaceutical legislation and regulations, and therefore the country of origin must be considered.

Even where the origin of health care products can be trace to a trustworthy manufacturer, the origin of raw materials for drug products cannot be easily determined. However strict procedures for testing the quality of raw materials are part of the GMP procedures and conformity to quality assurance measures can be confirmed during inspections of production sites.

One possible source of humanitarian health care goods is private or corporate donations in kind (PAHO 2001, 147). Humanitarian organizations need a clear strategic position concerning acceptance of donations of health care goods for further distribution in order to formalize a policy which can be disseminated among potential donors.

Problems with donations are manifold and notorious. The kind of donated health care goods may not be needed (PAHO 2001, 147), inappropriate for the context or not fit the epidemiology of the recipient country (WHO 1999a, 3). Unsolicited donations which arrive unsorted, unlabelled, poorly packaged, used or outdated are virtually useless (PAHO 1983, 8). Donors often have no insight into the priorities and may donate health care products which are not needed or have already been donated in sufficient quantities (Forte, G.B. 1994, 6). Unneeded health care goods waste transport and storage capacities. Finally donated drug products may simply be of poor quality (Forte, G.B. 1994, 6).

The manufacturers and suppliers are likely not to be registered and validated by the humanitarian organization and appropriate storage between manufacturing and donation is not ensured.

For health care goods which can be purchased domestically with the required quality, humanitarian organizations waste transport costs while increasing lead time for assisted health care facilities. In some cases transport costs may even exceed the value of health care goods (Forte, G.B. 1994, 6).

Donated health care goods are unlikely to be registered by the drug regulatory authorities in the recipient country and are often not part of the national essential drug programmes.

Health care goods which are not identifiable because of labelling in foreign languages or use of proprietary rather than international nonproprietary names require large resources of scarce health care workers for sorting and recording (PAHO 2001, 26).

The large number of different drug products in a multitude of dosage forms and presentations makes continuous treatment impossible and increases the complexity of logistics management.

Small packing quantities, for example in blister packaging, require large shipping and storage volumes.

The cost of appropriate disposal of unwanted health care goods has to be born by the humanitarian organization or the health authorities of the recipient countries.

Donations of drug products which do not conform to the World Health Organizations' guidelines must be discouraged (WHO 1999a, 6). Donations should be based on expressed needs and approval of recipients and be relevant for the context. They must be approved for use in the donor country, must be commonly used in the recipient

country and be obtained from reliable sources which comply with international quality standards. Samples or drug products returned from patients must not be donated (WHO 1999a, 8). The remaining shelf life upon arrival in the recipient country must be sufficient to use drug products before expiry. Drug products must be labelled in a language that is understood in the recipient country and hospital packs should be preferred.

However donations of required health care products and standard kits from registered manufacturers are useful.

4.2.2 Dual versus multiple sourcing

Relying on a single source for any health care product should be avoided as it creates a complete dependency (Schulte, Ch. 1999, 235). Inability of the single supplier to deliver, especially during emergencies, may quickly cause a stockout at the assisted health care facility. The risk increases if the single source supplies other humanitarian organizations which are likely to place large orders to the same supplier at the same time. Consequently humanitarian organizations should source health care goods from at least two reliable suppliers. An overview of criteria for choosing dual or multiple sourcing is shown in figure 4.4.

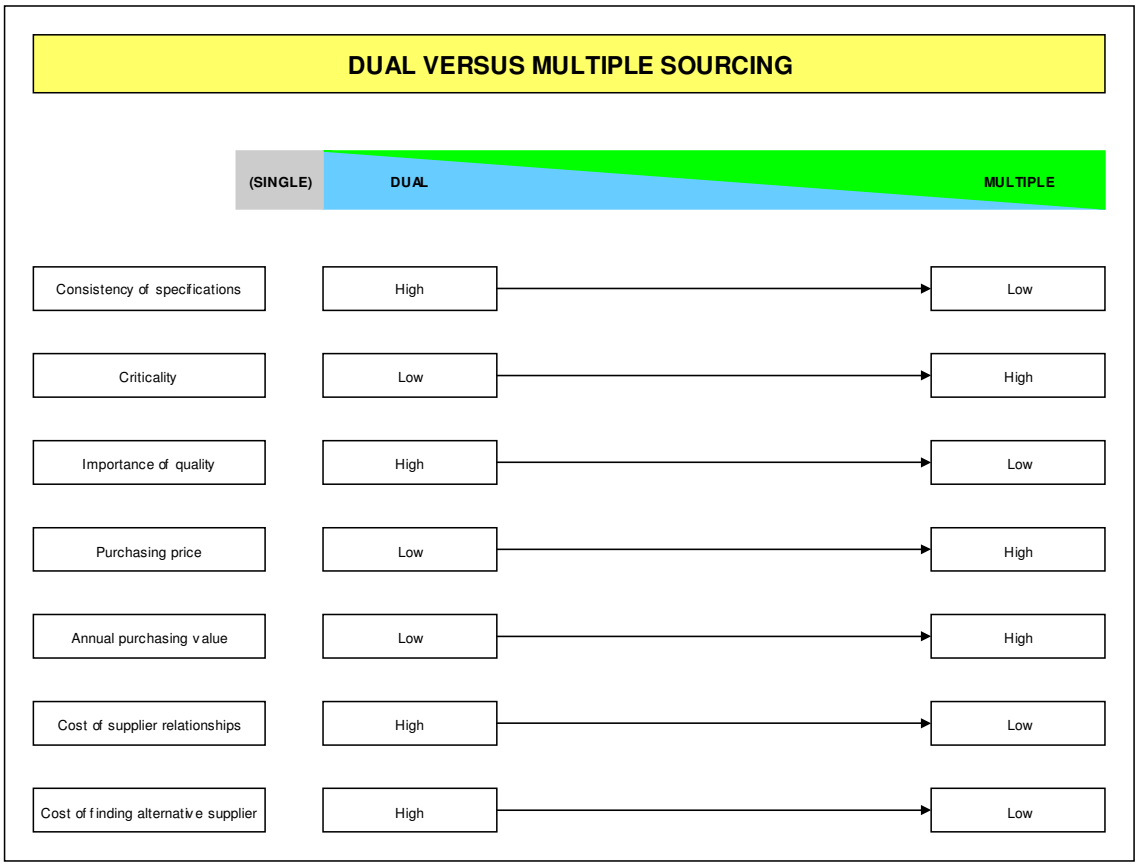

Figure 4.4 Dual versus multiple sourcing

Complete reliance on a single supplier also bears the risk of unavailability in case the manufacturing quality or supplier services suddenly deteriorate. Although a sudden increase of the purchasing price will not cause a stockout humanitarian organizations will have to bear the higher price until an alternative supplier can be found.

Single sourcing may be acceptable for health care goods which can be considered as commodities, which are available from a large number of suppliers and for which an alternative supplier can be found immediately.

Single sourcing may be inevitable for humanitarian assistance goods where only one supplier can offer products with the required specifications, such as sophisticated health care equipment. Purchasing similar health care equipment from several suppliers would carry the penalty of having to stock and provide several different sets of replacement parts and operating equipment. However, even where a specific product is selected as a standard, at least two intermediaries who hold stock should be available.

Relying on a single source may also be inevitable where drug products are available from only one manufacturer during the life of a patent. However most essential drugs have been on the market for decades and are available as multisource drug products.

Drug products for treatment of diseases not common in developed countries or rarely used vaccines may only be available from a single manufacturer because the market does not warrant competition.

In order to avoid dependency on suppliers as well as to allow a quick increase of purchased quantities in emergencies, at least two sources should be available for critical products (Quick, J.D. (ed.) 1997, 236). The availability of a second supplier also allows benefiting from the possibly shorter lead time of a second supplier (Tagaras, G. and D. Vlachos 2001, 416).

Unavailability of less critical health care goods will not jeopardize health care programmes as substitutes can be used until an alternative supplier is found.

Single sourcing of health care goods for which quality is critical allows enhancing quality assurance by concentrating available resources on a single manufacturer or supplier (Schary, Ph.B., and T. Skjøtt-Larsen 2001, 186). Moreover quality of purchased products is more consistent with single sources (Ehrmann, H. 2003, 297). On the other hand lack of competition and the impossibility to compare the quality of different products may decrease quality. Moreover, new developments of competitors may be missed.

For health care goods with low annual purchasing value, lower purchasing prices from competition among several suppliers are unlikely to offset the higher costs for maintaining relations with multiple suppliers. Conversely for expensive health care goods, such as equipment, or for goods with high overall purchasing value, multiple sourcing allows to benefit from competition and lower purchasing prices.

On the other hand humanitarian organizations may benefit from economies of scale by purchasing from a single supplier (Schary, Ph.B., and T. Skjøtt-Larsen 2001, 186) and must consider the trade-off.

High costs for sourcing, qualifying and regularly inspecting (alternative) suppliers, especially abroad, also favours dual rather than multiple sourcing.

4.2.3 Centralized versus decentralized purchasing

Purchasing strategies can be differentiated by the geographical scope of the customers they serve (Ehrmann, H. 2003, 476).

In the context of humanitarian assistance purchasing can be centralized in one location, often the head office country or in another developed country, which serves all assisted health care facilities worldwide. At the other extreme purchasing services would be decentralized in each country or even in each place where the humanitarian

organization assists health care facilities. Purchasing services can also be located between these extremes, serving a continent, geographical region (for example central America or the Middle East) or a number of adjacent countries.

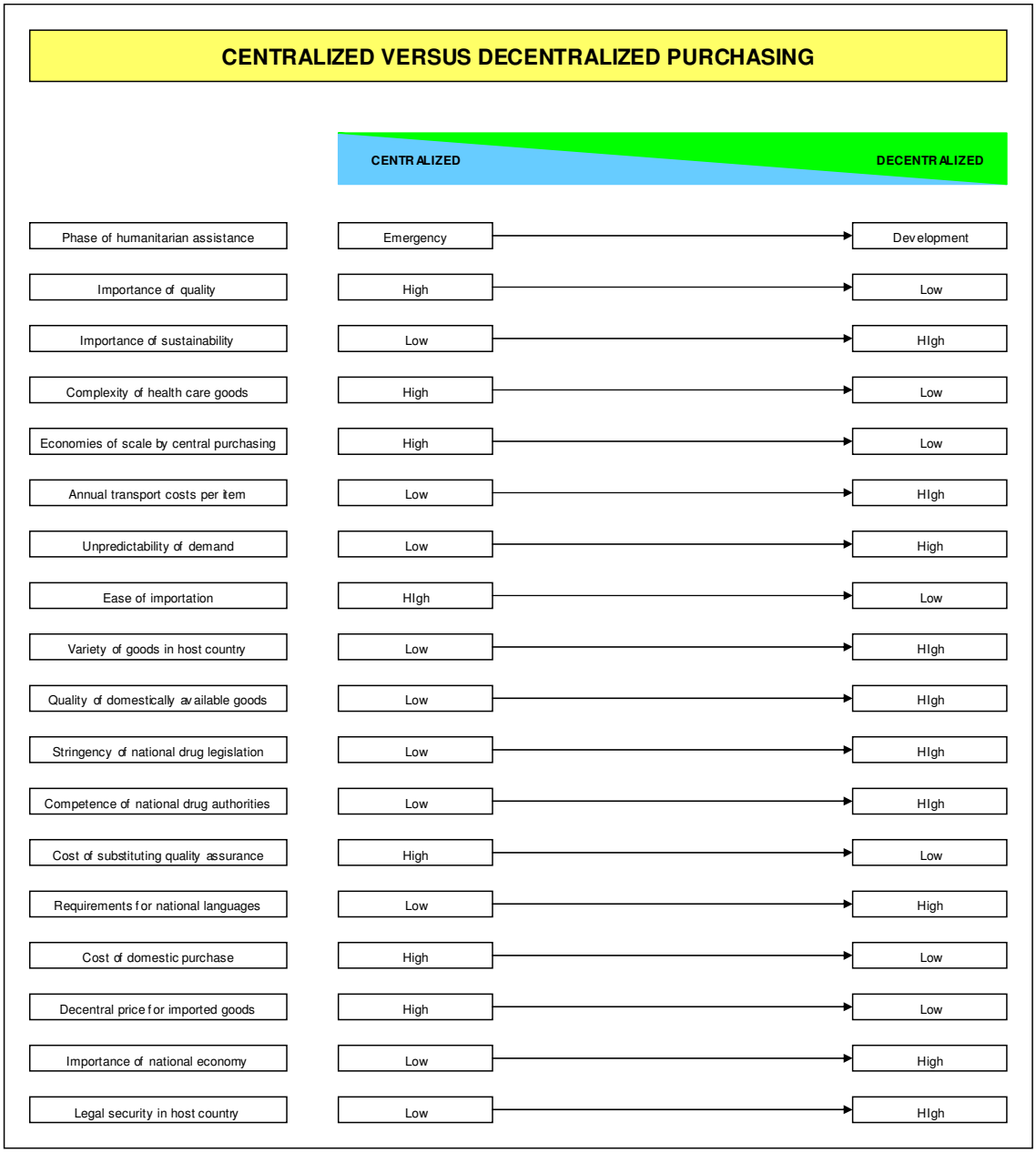

Figure 4.5 Criteria for centralized versus decentralized purchasing

The scope of purchasing does not necessarily coincide with the scope of sourcing. Centralized purchasing services may purchase health care goods in the country of the head office or internationally, either directly or through intermediaries. Conversely decentralized purchasing services may purchase health care goods in the country where they are located as well as regionally or even internationally through intermediaries.

For the same country of operations, the purchasing strategy may differ between different types of health care goods. For example drug products with high quality requirements may be purchased centrally while dressing material may be purchased

from domestic manufacturers. Likewise the strategy may differ from country to country where in one country the majority of health care goods may be purchased domestically while in another country all assistance goods are purchased centrally and shipped to the respective health care facilities.

However, in order to reduce transport costs and lead time, both centralized and decentralized purchasing services, will favour suppliers in their vicinity, provided that offered products comply with the required quality standards. The main consideration is the trade-off between low transport costs (cost) and short lead times (customer service) for decentralized purchasing and the increased risk of acquiring substandard and counterfeit health care goods (quality assurance) by purchasing in less developed countries. The criteria that need to be considered are shown in figure 4.5.

Regardless of the quality of available health care goods in the country receiving humanitarian assistance, the need for an immediate response to an acute crisis does not allow to survey the domestic or local market and qualify potential suppliers. Rather health care goods will have to be supplied from sources abroad until the availability and quality of health care goods in the domestic market have been assessed.

The risk of acquiring substandard or even counterfeit health care goods is generally higher in less developed countries because of lower manufacturing standards as well as a higher risk of importing counterfeit drug products. Consequently humanitarian organizations need to purchase health care goods where quality is critical centrally at least until a decentralized source of equal quality is identified.

Centralized purchasing in developed countries is likely to be unsustainable (Kaur, M. et al. 2005, 112) when assisted health care facilities or national health care systems eventually resume their self-sufficiency. Domestic purchasing services may lack the contacts to international manufacturers or, where health care goods are available through importers, products may be too expensive.

If products are selected for which manufacturers do not provide a worldwide service network, the principles of standardization runs contrary to the need to ensure sustainability. Consequently humanitarian organizations must decide on a case by case basis whether they follow, possibly lower, domestic standards or accept that the provided health care goods are only provided for the duration of humanitarian assistance programmes.

More complex and sophisticated health care goods, especially equipment, and the selected standard items are less likely to be available in less developed countries and will therefore require centralized purchasing. Moreover the need for quality assurance increases with the complexity of health care goods which also favours centralized purchasing.

Even for health care goods which are available decentrally through intermediaries, humanitarian organizations may prefer centralized purchase in order to benefit from economies of scale (Gadde, L.E., and H. Håkansson 2001, 156), provided that the savings exceed transport costs for international distribution.

In order to reduce overall annual transport costs of items for international distribution, heavy and bulky items such as infusions and dressing material, should be sourced decentrally, especially if the annual demand is high and their value density is low.

Unpredictability of demand favours decentralized purchase as centralized purchase may incur high costs for expediting shipments.

Restrictions on and delays for importation of health care goods into recipient countries favour decentralized and domestic purchase. High costs for registration of standard health care goods in the host country, which have not been registered by

domestic importers with the national drug regulatory authorities, also favour domestic purchase.

Rigorous national drug legislation may hamper importation, especially of not registered health care goods, and is likely to increase the quality of domestically available health care goods which both favour domestic purchase.

Health care goods need to be purchased abroad if they are unavailable in the host country or the range of available products does not allow covering all essential goods (Kaur, M. et al. 2005, 112).

Likewise substandard quality of domestically available health care goods, either manufactured domestically or imported, necessitates purchase abroad.

Highly developed and stringent national drug legislation as well as highly competent national drug regulatory authorities in host countries favour decentralized purchasing. The safety of imported as well as domestically manufactured health care goods increases and the cost of quality assurance decreases for humanitarian organizations. Moreover the likelihood that importation, even of high quality health care goods, is refused increases as the number of registered products is limited in any market. Domestic purchasing also furthers the domestic economy and improves relations with local authorities (WHO 1999c, 19).

The assumption is made that the quality assurance costs for centralized purchase are comparatively low in a developed country since manufacturers as well as intermediaries have to comply with rigorous quality standards and will be regularly audited by their respective national drug regulatory authorities. The cost of substituting quality assurance systems will be proportional to the shortcomings of national drug legislation and authorities but also depend on the range of health care goods which individual manufacturers or intermediaries offer. The costs for qualifying manufacturers and suppliers are basically the same whether a small quantity of a single product or large quantities of many products are purchased as the minimum quality standards are independent of quantities. Incurring high costs for auditing manufacturers or intermediaries may be cost-efficient if a large range of health care goods is offered and the total annual purchase value of those products is high. However generally high costs for substituting national quality assurance systems will favour centralized purchase.

Where national drug regulatory authorities require labelling in national languages, centralized purchasing may be impossible. For example multilingual labelling, including Arabic or Asian languages, is unlikely to be available in the European market and consequently domestic or at least regional purchasing may be necessary.

High costs for establishing and maintaining multiple decentralized purchasing services will also favour centralized purchasing, even if high quality health care goods are available domestically.

Depending on the mark-up of domestic importers, centralized purchasing may be more cost-efficient than domestic purchase, even when international distribution costs are considered. Especially where domestic importers have reserved exclusive rights for health care goods, the competition among suppliers is likely to yield lower prices by centralized purchasing. On the other hand importers are likely to benefit from economies of scale for transportation and are more likely to be able to use slower surface transport for replenishing their stocks.

Although, unlike food purchase, domestic purchase of health care goods is unlikely to have a significant impact on the national economy, domestic purchase may be desirable for political reasons and to show respect for the host country.

Lack of legal security in the host country will strongly favour purchase abroad.

While the decision on centralized or decentralized purchase needs to take all above criteria into consideration and compare the overall costs of ownership, the costs associated with quality assurance are of particular importance. Transport costs are also an important criterion since important health care goods have low value but high weights (for example infusions) or high volumes (for example dressing materials). The trade-off between the annual costs for decentralized purchase of health care goods and the annual transport costs for centrally purchased goods is critical (figure 4.6).

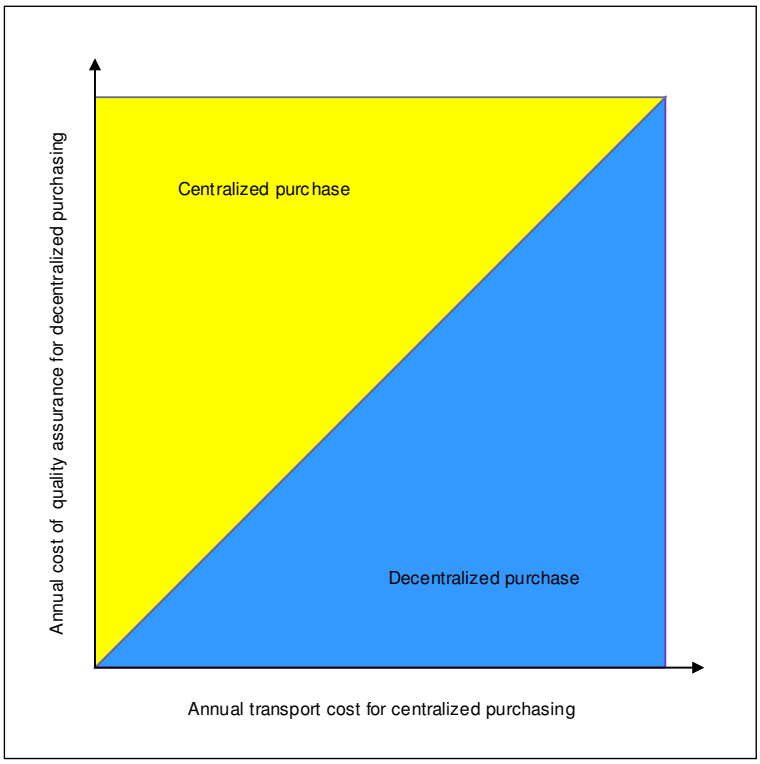

Figure 4.6 Centralized versus decentralized purchasing

The annual cost of quality assurance for each decentrally purchased item depends on the national drug regulatory authorities, the cost for substituting quality assurance systems and on the number of different products one supplier is offering.

One of the main disadvantages of centralized purchasing is the high cost of international distribution especially if air transport is commonly used to avoid deterioration of health care goods due to shorten transport time.

Consequently humanitarian organizations should focus on decentralized purchase of heavy and bulky items such as infusions or dressing material with high annual turnover and therefore high annual transport costs, provided that the (higher) cost for quality assurance incurred by decentralized purchase is offset by lower transport costs.

4.2.4 Width of supplier base

The width of the supplier base refers to the overall number of suppliers (Gadde, L.E., and H. Håkansson 2001, 155) which are qualified and have been registered by the respective humanitarian organization. The width of supplier base is related to but does not coincide with the issue of dual versus multiple sourcing. Single sourcing each item from a different supplier leads to a wide supplier base while dual

sourcing from two wholesalers offering the full range of required health care goods results in a narrow supplier base.

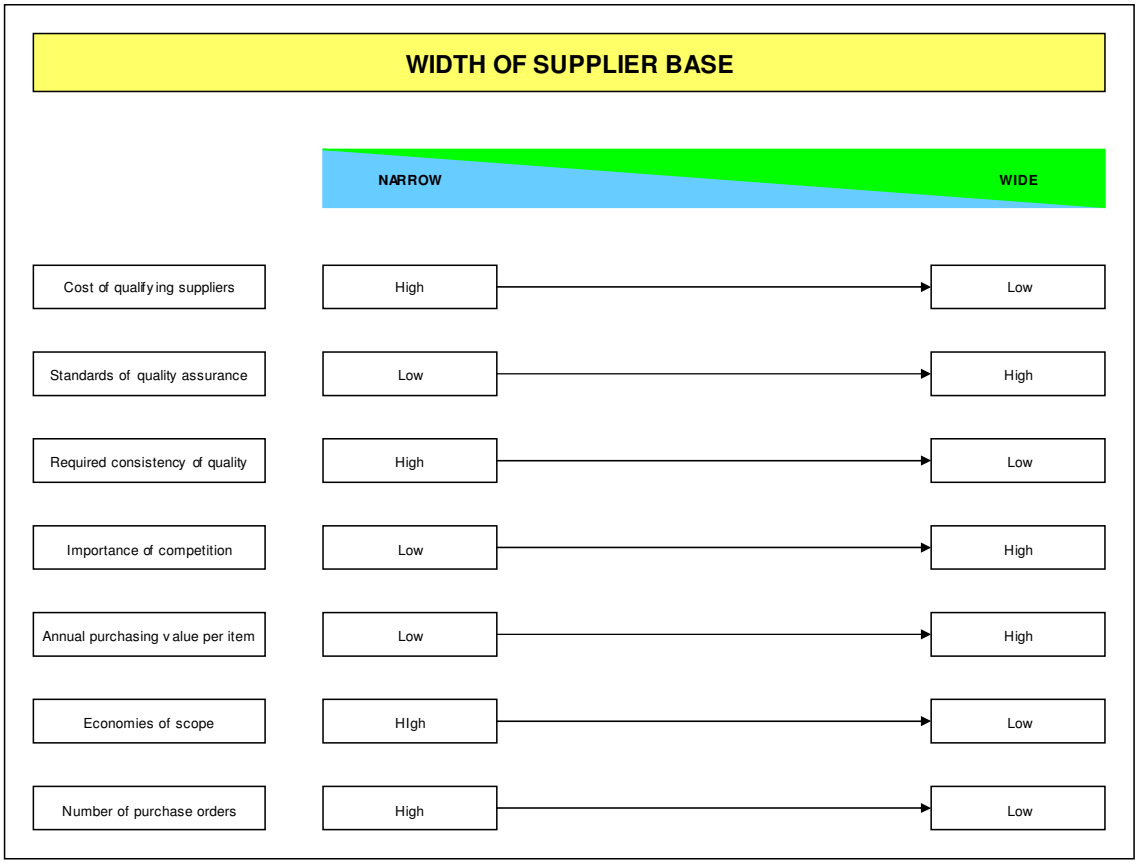

Figure 4.7 Width of supplier base

Generally, the required resources to maintain a large number of supplier relationships favour limiting the supplier base (Gadde, L.E., and H. Håkansson 2001, 174).

At the one extreme, each health care product is purchased from the supplier offering the best quality, price and services. While no manufacturer produces a full range of necessary health care goods, the supplier base can be reduced by purchasing all necessary health care goods which are available from that supplier, regardless of the price. At the other extreme all goods would be purchased from a single wholesaler. The issues which need to be considered are summarized in figure 4.7.

The costs for qualifying new manufacturers and suppliers depend on the costs for specialists to carry out detailed audits and the physical distance between manufacturers or suppliers and the purchasing service.

The cost associated with auditing and qualifying suppliers also depends on the stringency of national drug legislation and authorities. Where national quality assurance systems are weak, the cost of thorough auditing of a large number of individual manufacturers and suppliers can be prohibitively high.

The benefit of higher consistency of quality within a range of products, such as injection supplies, sutures or surgical instruments, may outweigh the cost savings which could be achieved by purchasing individual items from different suppliers.

Ensuring compatibility of equipment and health care devices may also require purchasing from a single supplier even if cost savings could be achieving by purchasing individual health care goods from different suppliers.

For health care goods where competition is likely to improve quality and reduce prices, a wider supplier base is favourable. Humanitarian organizations can then quickly take advantage of the most suitable health care goods without having to source new suppliers or establish new supplier relationships at short notice.

For health care goods with a low annual purchasing value, the cost savings from minimizing prices by purchasing each product from a different supplier are unlikely to compensate for the fixed costs associated with maintaining several supplier relationships (Gadde, L.E., and H. Håkansson 2001, 158).

For health care goods or ranges of products where the annual purchasing value is significant enough to benefit from economies of scope, narrowing the supplier base can be an advantage (Gadde, L.E., and H. Håkansson 2001, 35).

Reducing the width of the supplier base allows to consolidate and therefore reduce the number of purchasing transactions which are each associated with a fixed cost (Audit Commission 1996, 23).

A related issue is purchasing directly from manufacturers or through intermediaries such as distributors or wholesalers. Appointed and authorized dealers which offer the full product range of a manufacturer will not necessarily reduce the number of suppliers but will allow purchasing without the need for importing goods from the country of manufacture. However intermediaries have to be qualified and every intermediary between the humanitarian organization and the manufacturer increases the risk of purchasing substandard or even counterfeit health care goods (WHO 1999, 16). Especially when purchasing in less developed countries it may be difficult to trace the supply chain back to the manufacturer. Moreover the danger of deterioration due to inappropriate storage also increases with the number of intermediaries. Therefore health care goods where the quality is highly critical should be purchased as near to the source as possible (Dörner, G. (ed.) 1992, 5).

Wholesalers offer a wide range of different health care goods from several manufacturers and therefore allow reducing the width of the supplier base considerably. Even outsourcing all purchasing activities to a single wholesaler could be considered.

Wholesalers lower transaction costs as a large number of orders for individual items can be replaced by larger consolidated purchase contracts for a wide range of health care goods (Burt, D.N., D.W. Dobler, and St.L. Starling 2003, 346). Likewise transport between wholesaler and the store of the humanitarian organization can be consolidated. Warehouse operations are also facilitated as staff does not need to receive smaller shipments from a large number of different suppliers.

Wholesalers offer the additional advantage of being able to offer substitutes if the primary supplier is unable to deliver without the humanitarian organization having to urgently source for an alternative supplier.

Humanitarian organizations can benefit from economies of scale and large annual purchasing values will encourage wholesalers to provide high quality services.

Possible disadvantages are dependency on a small number of suppliers (wholesalers) and potentially high switching costs if humanitarian organizations are not satisfied with the services they receive. The mark-up of wholesalers on the manufacturer prices may be offset by lower transaction costs.

One means of reducing the width of the supplier base is by outsourcing the manufacturing of pre-packed kits rather than purchasing individual health care goods and assembling kits. Specialized suppliers offer pre-packed field hospitals with hundreds of items which can be purchased off the shelf in modules or as a single item.

4.2.5 Sourcing strategy

Since speed of response is essential during the contingency phase and the initial emergency response, goods will have to be sourced from pre-qualified and established suppliers with a record of reliably providing health goods of good quality (see figure 4.8).

In order to avoid complete dependency, humanitarian organizations should at least source health care goods from two suppliers. However efficiency and the need for a quick response do not allow sourcing from multiple sources at this stage. During later stages of humanitarian assistance where the objective is sustainability of health services and short lead times are less important, humanitarian organizations can benefit from the advantages of multiple sourcing.

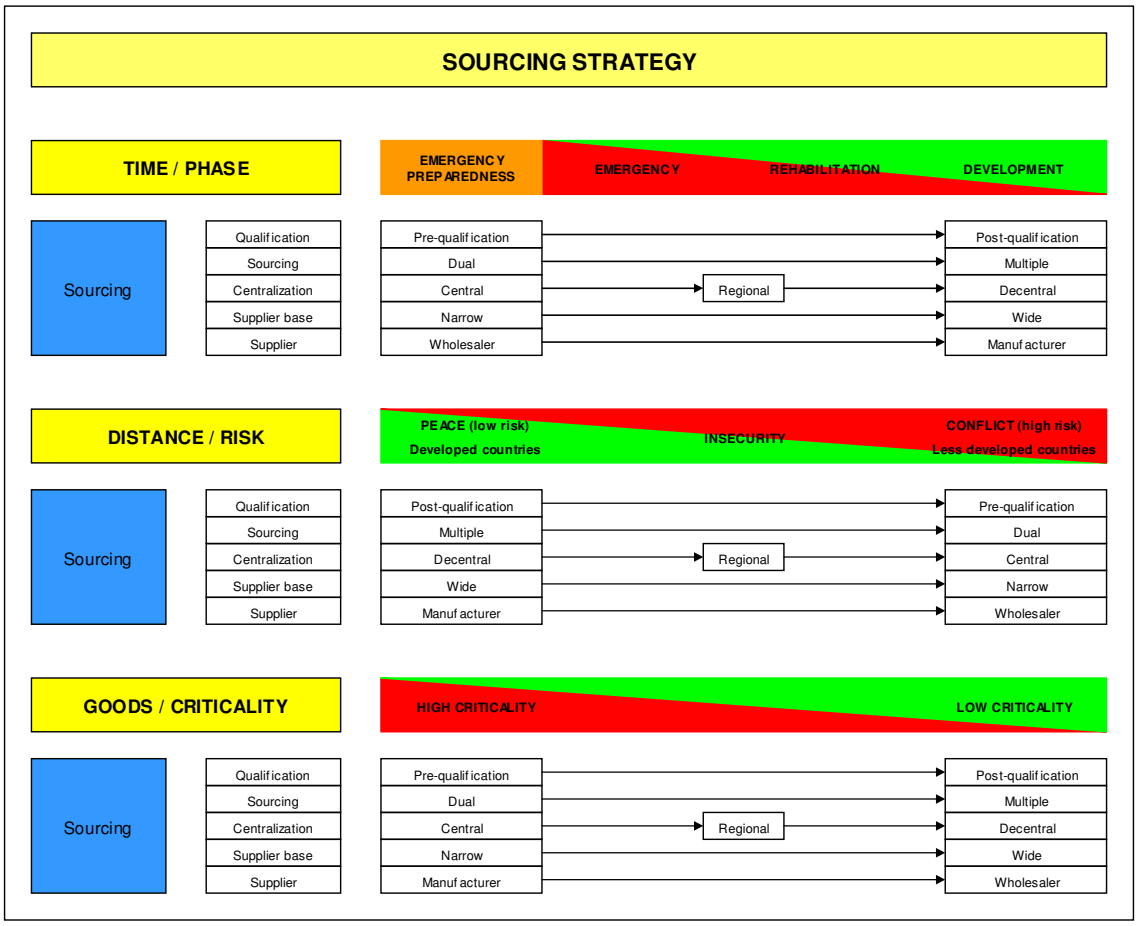

Figure 4.8 Sourcing strategy

Since an immediate response to emergencies is imperative, centralized purchasing from known and well established suppliers is necessary. During the rehabilitation and development phase, purchasing services can move closer to the country receiving assistance and inside the country nearer to assisted health care facilities.

The imperative of simplicity and efficiency during the emergency requires limiting the width of the supplier base which can be expanded at a later stage especially in view of facilitating sustainability and self-sufficiency of health care programmes.

During the emergency phase lead times and purchasing resources can be reduced by purchasing health care goods from a small number of wholesalers, even if overall purchasing costs are higher. During later stages direct purchases from manufacturers may allow to benefit from lower prices.

The general insecurity will favour purchasing goods only from known and pre-qualified suppliers or resorting to centralized purchasing instead. Post-qualification requires more human resources and time and is therefore more suitable for purchasing services in safe markets.

The complexity of multiple sourcing and a wider supplier base is reserved to places further away from the conflict area for the same reason.

Since commercial activities for health care goods are likely to have decreased in and near the conflict area, in most cases assistance goods will have to be provided from centralized purchasing services in secure countries. With increasing security, regional, domestic and eventually local purchasing can be resumed provided the quality of health care goods can be ensured.

Pre-qualification should be used for critical health care goods since assessments of suppliers and the quality assurance measures are more thorough while for less critical health care goods post-qualification is sufficient.

Assessing manufacturers and suppliers requires considerable resources. Therefore the number of potential suppliers should be limited for highly critical health care goods in order to concentrate available resources on a few but thorough rather than many more superficial assessments.

Highly critical health care goods, which therefore require high quality standards, should be sourced centrally as the required quality assurance resources are more likely to be available and can be used more economically for a few suppliers.

Wherever possible, highly critical health care goods should be purchased directly from the manufacturer, or at least as close to the manufacturer as possible, rather than through intermediaries in order to ensure their high quality.

4.3 Facility network design

The supply network (Chopra, S., and P. Meindl 2004, 5) consists of nodes (facilities) and links (transport routes) which connect multiple sources with the recipients of humanitarian assistance and through which goods and related information flow.

Since humanitarian organizations are concerned only with distribution of finished goods, nodes are either storage facilities or places where goods change the mode of transport (Pfohl, H.Ch. 2000, 350). The supply network can be seen as the collection of all possible paths or routes along which goods and related information can flow (Chopra, S., and P. Meindl 2004, 60) with or without intermediate storage at its nodes. However goods do not necessarily have to flow through all nodes between the manufacturer and the end-user.

The internal supply chain (see figure 4.9) extends from the receiving store managed by the humanitarian organization to the last downstream store managed by the same organization. The external supply chain extends beyond the humanitarian organization and includes the immediate upstream supplier as well as the recipient or receiving health care facility.

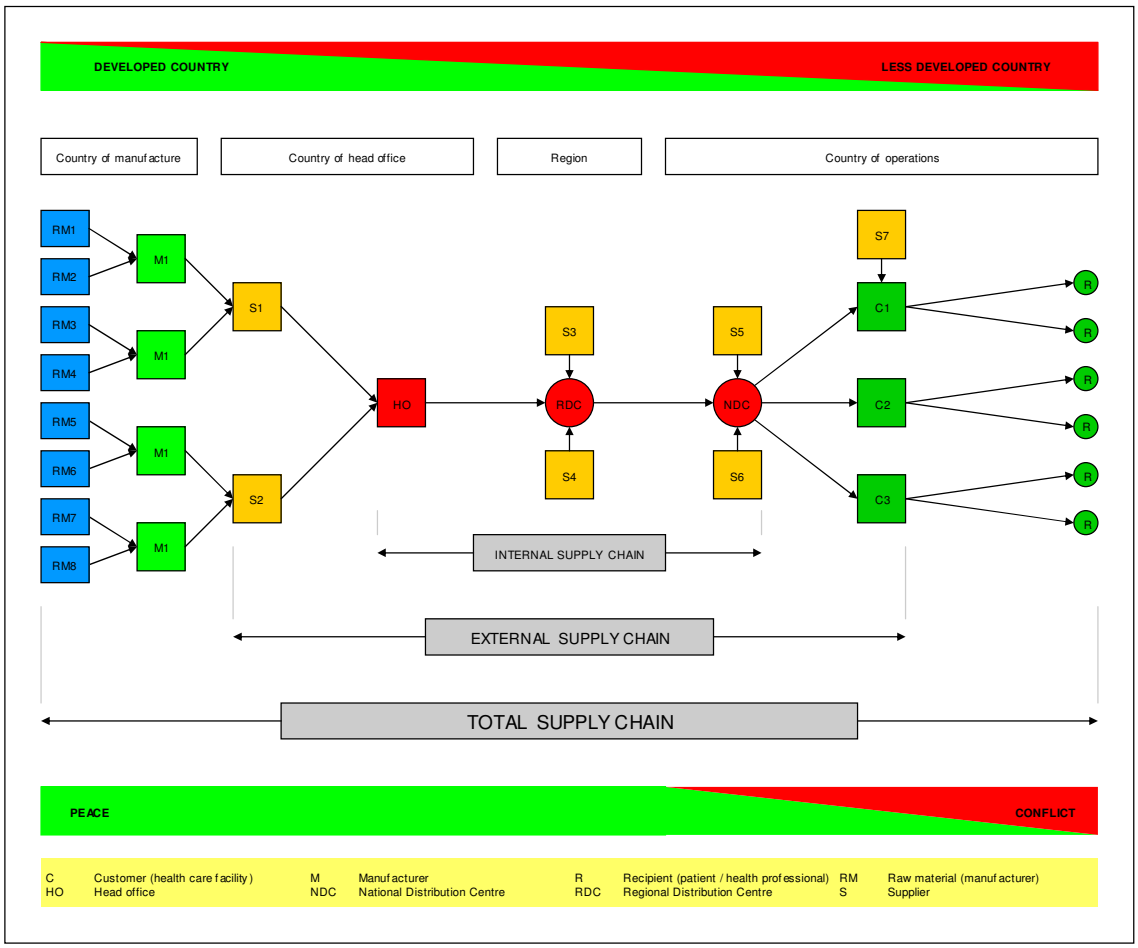

Figure 4.9 Total, external and internal supply chain

While the length of the supply chain between the manufacturer of finished goods and the end-user is determined by their respective locations, the length of the external supply chain may vary from extending from the manufacturer to the end-user or being entirely outsourced with direct deliveries from the manufacturer to the end-user without involving logistics services of the humanitarian organization. Finally the total supply chain extends from the manufacturers of raw materials to the final user or recipient of health care goods.

Humanitarian organizations must take a strategic decision to determine the borders between their own supply network (Gudehus, T. 1999, 36) and the global commercial supply network of which it is a part.

4.3.1 Facility location

The facility network design must determine the number, location as well as capacities of facilities (Lambert, R.S., and J.R. Stock 1993, 305). This chapter will first analyse the reasons why humanitarian organizations must maintain stocks and storage facilities, summarize relevant constraints and review some models before developing a strategy for designing the facility network. The strategy will consider only the facility network of the humanitarian organization and disregard the facility network of third party distributors.

The delivery of all health care goods from the manufacturer directly to assisted health care facilities would avoid costs and risks associated with their intermediate storage

and handling (Gudehus, T. 1999, 269). Even if the best store is no store at all (Koether, R. (ed.) 2004, 50), in practice maintaining intermediate storage facilities is necessary for numerous reasons (Lambert, R.S., and J.R. Stock 1993, 263). However, storage facilities must not be added to a facility network unless they can be justified considering the trade-off between service and cost (Bowersox, D.J., and D.J. Closs 1996, 392). Generally supply networks should be as simple as possible and legs which do not add any value to customers should be eliminated (Klaus, P. 2004, 352).

Careful inspection of all health care goods entering the internal supply chain by a qualified pharmacist is an indispensable quality assurance measure. Since finding and employing qualified staff downstream near the assisted health care facilities is more difficult or impossible, inspection needs to be centralized further upstream in the supply network. Centralizing inspection allows reducing the resources required for inspection (Jessop, D., and A. Morrison 1994, 226) but in turn requires intermediate storage before further distribution. As every batch requires inspection, purchasing larger quantities less frequently allows reducing required resources for inspection but also requires maintaining stocks.

Purchasing larger quantities of health care goods at a time allows benefiting from economies of scale by negotiating lower purchasing prices (Rushton, A., J. Oxley, and Ph. Croucher 2000, 233), reducing transaction costs by reducing the purchasing frequency as well as reducing transport through less frequent supplier deliveries (Lambert, R.S., and J.R. Stock 1993, 267).

Stocks are necessary to hedge against uncertainty of supply (Pfohl, H.Ch. 2000, 100) which can occur at all stages along the supply network for various reasons. Health care goods, such as customized kits, may not be manufactured continuously and therefore not be available from the supplier immediately. Stockouts may occur at the supplier for a variety of reasons and during emergencies, when demand suddenly surges. Delivery of available goods may be delayed, goods damaged during transport or rejected during inspection for non-conformity to the required specifications and quality (Steinbuch, P.A. 2001, 315).

Especially in countries receiving humanitarian assistance, customs clearance may be slow or delayed, borders and transport routes may be blocked for security reasons or by sanctions and transport routes may be damaged by natural causes (floods, landslides etc.) or effects of warfare.

As schedules as well as capacities of different means of transport usually cannot be completely synchronized, temporary storage of consignments is necessary at nodes where means of transport are changed (Pfohl, H.Ch. 2000, 125), for example between road and air transport.

Maintaining stores allows to consolidate several shipments from different stores and to benefit from transport economies (Lambert, R.S., and J.R. Stock 1993, 267). Consolidation of shipments is mandatory when using expensive cargo aircraft. Besides transport frequencies may be limited and irregular for security reasons or because of blocked transport routes. Especially in the conflict area, transport frequencies may be limited by transport costs and available resources, especially when using small aircraft.

Since health care facilities require regular delivery of numerous different health care goods, direct shipment from a large number of suppliers requires a consolidation point (CP) for transport efficiency. Suppliers may be unwilling to ship small quantities of products directly to a large number of customers and direct shipment is usually impossible in the conflict area for security reasons or unavailability of transport means.

Stores allow receiving numerous health care goods from different suppliers, serve as a break bulk point, combine goods from different suppliers and consolidate outbound consignments to individual customers (Lambert, R.S., and J.R. Stock 1993, 265).

Storage facilities may also be necessary for manufacturing kits (Rushton, A., J. Oxley, and Ph. Croucher 2000, 233) if they are not already manufactured by suppliers.

Maintaining buffer stocks is also necessary to hedge against uncertainty of demand (Lambert, R.S., and J.R. Stock 1993, 268) caused by the unpredictability of the conflict, a sudden influx of patients as well as unforeseen movement of displaced populations. Other reasons for unpredictability of demand are seasonal diseases and epidemics.

Unforeseen increases of established assistance to health care facilities as well as an increase in the number of assisted facilities, changes of treatment schedules as well as calculation errors, damage of stocks and expiry of goods can also cause unexpected variations of demand.

For developing the facility network strategy the context in which humanitarian organizations work and some specific constraints need to be considered.

The risk that access to assisted health care facilities is blocked by parties to the conflict and therefore the inability of humanitarian organizations to provide required health care goods, increases with the distance to the supplying storage facility. On the other hand the safety and security risks for staff, storage facilities and stocks decrease with increasing distance to the conflict area. The primary concern for logistics managers is minimizing the exposure of staff, assets and goods to conflict related risks. Storage facilities must be located in the safest available areas which are exposed as little as possible to conflict related risks.

National borders and front lines may have to be considered as impassable for political and security reasons, even if the physical distance between assisted health care facilities and an ideally located storage facility across the divide is small. Minimizing the risk of transport between stores and assisted health care facilities takes priority over minimizing transport costs. Transit along the shortest route through a third country may also be impossible for security reasons.

Locating storage facilities close to assisted health care facilities reduces the risk that transport routes between them are blocked as a consequence of the conflict. However, although intentional attacks on health care facilities are considered as a war crime (Rome Statute Art. 2.b (ix)), locating stores in the conflict area also increases the risk that staff are harmed and goods looted, damaged or destroyed. Consequently logistics managers must seek a compromise between ensuring the reliable supply of health care facilities even during intense warfare and limiting the safety and security risks to acceptable levels.

In order to ensure instant availability of health care goods, even in peace times, hospitals will maintain stocks irrespective of stock holding costs (Harrison, A., and R. van Hoek 2002, 90). Blocking, shelling, looting or damage to a central storage facility in the conflict area carries the risk that supply to all assisted health care facilities will be interrupted. This risk can be dispersed and therefore reduced by locating stocks directly at assisted health care facilities. If one health care facility and its store are damaged or destroyed, the others still can continue to provide services. However in order to provide the same level of service to several health care facilities, overall higher echelon stocks are required than with one central storage facility.

The locations of recipients are determined by health programme managers based upon a needs assessment, cannot be changed by logistics managers and can therefore be considered as fixed (Gudehus, T. 1999, 74). However logistical constraints should be considered by health programme managers in their planning.

Because of the limited funding, lack of security and the overall difficulties of providing humanitarian assistance in the context of high insecurity, compared to commercial organizations in developed countries, the number of health care facilities assisted by individual humanitarian organizations in the respective countries is low.

The overall strategy for designing the facility network must be global since complex political emergencies can in principle emerge anywhere in the world.

The sources of health care goods are determined by the strategic considerations developed earlier. The complexity of and required resources for supply chain management will decrease with the distance between suppliers and assisted health care facilities. Therefore local purchasing will be preferred to domestic and domestic to international purchasing, provided that all suppliers comply with the required quality standards.

Even if high quality health care goods are available from domestic suppliers, the facility network strategy must consider alternative sources from abroad since the necessary time for qualifying suppliers will not be available during the emergency phase.

The facility network strategy must consider the possibility of significant delays for customs clearance by sanctions or the authorities on either side of international borders. The possibility of a complete and permanent closure of international borders as well as front lines must be considered in any case.

Storage facilities should be located along or near reliable transport routes (PAHO 1983, 61), mainly roads, as well as in the vicinity of railway stations, ports, airports or airstrips. However this requirement has to be balanced against the risk of this infrastructure becoming a military target (Bickley, S. 2003, 49). Transport times, which depend among others on conditions of transport routes and delays caused by parties to the conflict, rather than physical distances, need to be considered.

The geographic location of storage facilities as well as the site selection will first of all require the acceptance by the conflict parties as well as the community and also depend on the available infrastructure and resources. Renting warehouses and stores does not require investment and avoids losses to the humanitarian organization in case buildings are damaged during the conflict and are therefore preferable to constructing buildings. Moreover, in emergencies storage facilities must be available immediately. Where several suitable stores are available, cost will be a determining factor of selection. Availability of qualified staff may be a further selection criterion.

Electrical power supply is essential where refrigeration or air conditioning are needed as well as for operating telecommunications equipment. Water supply is needed for general sanitation as well as cleaning of stores. Availability of (international) telephone lines is also an important criterion. Lack of these resources can be substituted by installing generator sets, sinking wells and setting up independent telecommunications networks but increases the cost for setting up as well as maintaining stores.

The storage and distribution needs for other assistance programmes by the same humanitarian organization will also be a determining factor. Where humanitarian organizations have already established offices and storage facilities, for example for food, accommodating health care goods in the same location will reduce costs. However, since customers for different assistance goods may not be located in the

same places, the location of a storage facility might be suitable for one set of customers but less suitable for the other set. The location of consolidated storage facilities will eventually be determined by the type of assistance goods with the largest volumes of distribution. Similar considerations apply for transport means which have already been deployed for distributing assistance goods other than for health programmes or for transport of staff.

Several traditional quantitative warehouse location models are based on minimizing costs or maximizing profits (Klose, A., and P. Stähly 2004, 482).

Von Thunen's model proposes a strategy based on minimizing transportation costs of products while Weber's model attempts to minimize costs for transporting raw materials to a manufacturing plant as well as finished goods to the market (Lambert, R.S., and J.R. Stock 1993, 313). Hoover's model considers the decrease of relative transportation costs with increasing distances which favours locating facilities further downstream rather than at intermediate locations. Greenhut included other factors such as the environment and security and his model aims at maximizing overall profits. As the primary objective of humanitarian organizations is to maximize reduction of suffering, neither minimizing costs nor maximizing profits can be a primary objective.

Hoover distinguishes between market positioned, production positioned and intermediately positioned location strategies (Lambert, R.S., and J.R. Stock 1993, 311). The market positioned strategy locates facilities near to the final customer in order to maximize customer service. Production positioned warehouses are located near the sources of products and serve as collection and mixing facilities for products from different sources which reduces customer service but allows to consolidate shipments. The third location strategy is a compromise where facilities are located between sources and customers in order to balance service levels and transport costs.

Quantitative location models can also be divided into planar models, network models and discrete models (Klose, A., and P. Stähly 2004, 483). In planar models the sum of distances between the facility and all customers it serves is minimized.

Network models are more realistic as potential locations of facilities are restricted to the vicinity of the transport network (Lambert, R.S., and J.R. Stock 1993, 317).

Discrete models consider fixed as well as variable facility costs and select the best facility location from a limited number of feasible options (Mau, M. 2002, 32).

Facility network designs can be approached by starting from the sources of goods or by considering the location of end-users and planning the supply chain backwards up to the sources (Klaus, P., and W. Krieger (ed.) 2004, 446).

Since it is not possible to quantify all relevant criteria for designing the network, decision makers must ultimately use their judgment (Simchi-Levi, D., Ph. Kaminsky, and E. Simchi-Levi 2003, 307). Exact algorithms require exact data and often require complex computations while heuristics allow providing good but not optimal solutions (Simchi-Levi, D., Ph. Kaminsky, and E. Simchi-Levi 2003, 302). The analysis of constraints allows eliminating certain solutions beforehand and limits the number of possible solutions from which the final solution can be selected (Gudehus, T. 1999, 75).

Since the complexity of the context as well as various aspects such as the security situation or transport infrastructure are difficult to model mathematically, the strategy will be developed by reasoning and heuristics.

A general framework for building a facility network design can be derived by starting from the simplest possible network and expanding it by successively considering the strategic objectives, premises, constraints and the overall context developed above.

In a direct shipping network (Chopra, S., and P. Meindl 2004, 420) all goods are shipped directly from suppliers (S) to the respective customer (C) or recipient (figure 4.10). This facility network is the simplest in the sense that it does not require establishing or maintaining any intermediate storage facility (Pfohl, H.Ch. 2000, 6).

Figure 4.10 Direct distribution

However, direct distribution would require feasibility for and willingness of suppliers to ship goods directly to health care facilities in a conflict area. Because the required health care goods are often not available with the required quality in countries of the recipients, direct shipment would require transport across international borders with the associated risk of delays. Direct shipments would also make health care facilities dependent on lead times offered by the respective supplier. Direct shipments would only be economical if the quantities allow fully utilizing means of transport (Gudehus, T. 1999, 21) which is unlikely with a large number of suppliers.

Health care facilities require a significant amount of different health care goods and individual shipments of a few items from several suppliers to a single customer leads to inefficient transportation. Especially where the majority of health care goods are sourced from abroad, a consolidation point (CP) is necessary near to the suppliers (Gudehus, T. 1999, 22) which corresponds to a convergent system (Minner, St. 2000, 64). Goods from different suppliers are received, inspected, consolidated according to customer orders and shipped to the customer by benefiting from transport economies (figure 4.11 A). This system also has the advantage that customers can be supplied with all necessary health care goods with a single shipment (Bowersox, D.J., and D.J. Closs 1996, 483).

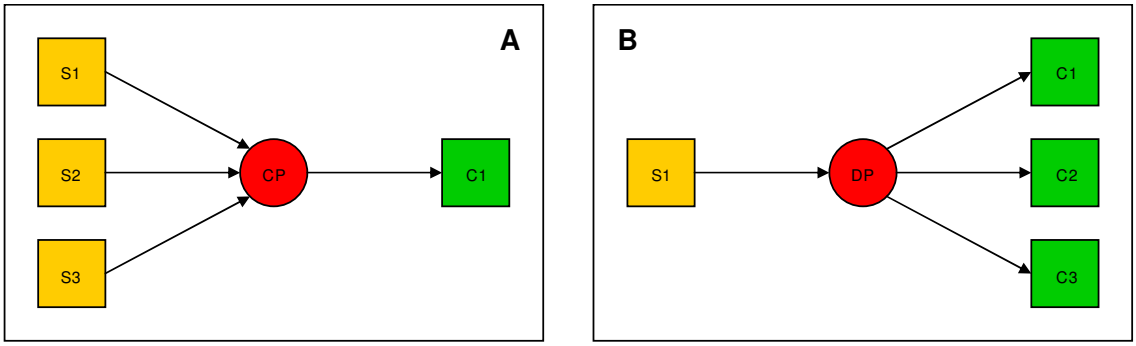

Figure 4.11 Consolidation and distribution point (Pfohl, H.Ch. 2000, 6)

This consolidation point may be located in the recipient country, a neighbouring country, a regional distribution centre or the country where the humanitarian organization is headquartered. A storage facility, which may be located at the head office or in another country, where health care goods are purchased and stored for further worldwide distribution to all health care facilities supported by the respective humanitarian organization, will be called an international distribution centre (IDC).

Likewise direct shipment of individual consignments from one supplier to several customers leads to inefficient transport, especially when suppliers are located abroad. Consequently an intermediary storage facility is needed to receive consignments from

suppliers, break bulk, prepare smaller consignments according to individual customer orders and distribute consignments to the final customer. Figure 4.11 B corresponds to a divergent system (Minner, St. 2000, 63). This distribution point (DP) can be located in the geographical region or within the country. However hedging against the risk of delays for customs clearance and closed borders requires a national distribution centre in the country where humanitarian assistance is supplied (Bichler, K., and N. Schröter, 178). As will be discussed later, a national distribution centre is also necessary for immediately responding to any emergency in the country.

As far as the security situation allows, this distribution point should be located near to the assisted health care facilities. Because of the relatively small number of health care facilities humanitarian organizations assist inside a given country, a single storage facility, which will be called a national distribution centre (NDC), should supply all customers in this country. A single storage facility requires fewer resources and allows providing the same level of service with lower echelon stocks than several distribution centres in the country (Gudehus, T. 1999, 33).

In networks with long transport lead times between national distribution centres and health care facilities, a large number of assisted health care facilities or the danger that transport between national distribution centres and health care facilities may be interrupted by warfare the question of the need of an additional tier of storage facilities arises. Additional tiers increase complexity (Thorn, J. 2002, 14), incur additional costs for establishing and maintaining storage facilities and increase demand distortion.

Generally larger numbers of customers and larger number of smaller consignments favour a more decentralized distribution with additional tiers of storage facilities (Ehrmann, H. 2003, 472). Additional regional storage facilities for serving a region within a country could only be justified if significant transport economies can be gained from consolidating transport between the national distribution centre and the regional store. However the overall volume of health goods required for assisting health care facilities is low and humanitarian organizations usually assist only a limited number of health care facilities.

On the other hand the danger of transport routes being interrupted by warfare is always a danger that must be considered. However establishing additional storage facilities between national distribution centres and assisted health care facilities does not eliminated this risk. Even storage facilities located within the same town or city of health care facilities receiving assistance may be cut off by rapidly changing front lines. Besides delivery of heath care goods even from nearby stores may be impossible for security reasons during open combat, shelling or aerial bombardments. Looting, damage or destruction of the regional store will deprive all assisted health care facilities of further supply.

The only way of preventing interruption of supply is by locating storage facilities within the premises of assisted health care facilities either by extending pharmacies and medical stores or by establishing additional storage facilities. During a crisis no facility can be considered as absolutely safe. However the relative safety of health care facilities is one of the major criteria for assisting them. Moreover health care facilities are protected under International Humanitarian Law und must never be attacked (First Geneva Convention, Art. 19).

Compared to a regional store, increasing the storage capacity at each health care facility or establishing an additional store at the health care facility increases the overall storage costs as well as overall storage levels. However storage facilities at health care facilities are the only way of avoiding interruption of supply and fulfilling the primary requirement of effectiveness. Moreover any additional echelon such as regional stores increases demand distortion while increasing stock levels at assisted

health care facilities does not, provided that all stocks at the health care facility are managed as one entity.

Establishing storage facilities within health care facilities or within their premises has the additional advantage of availability of resources and services such as security, water and power supply. Where available, storage facilities can be established in empty buildings and therefore do not require renting or building facilities. Health care facilities, rather than landlords of rented facilities, can also benefit from any repairs or renovations of existing buildings after humanitarian organizations end their assistance.

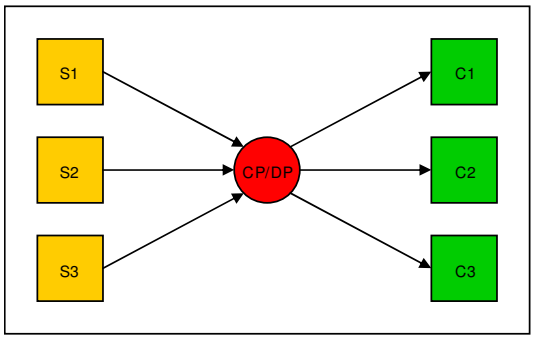

Figure 4.12 Joint consolidation and distribution point

Where humanitarian organizations purchase goods from several suppliers and distributed them to several health care facilities (figure 4.12), an intermediary storage facility can serve as a consolidation as well as break bulk and distribution point at the same time (Pfohl, H.Ch. 2000, 124).

Since health care goods are often sourced outside the country of final distribution, a consolidation point is needed near to the suppliers (figure 4.13) in order to benefit from transport economies and a second storage facility is needed near to the customers (Gudehus, T. 1999, 22).

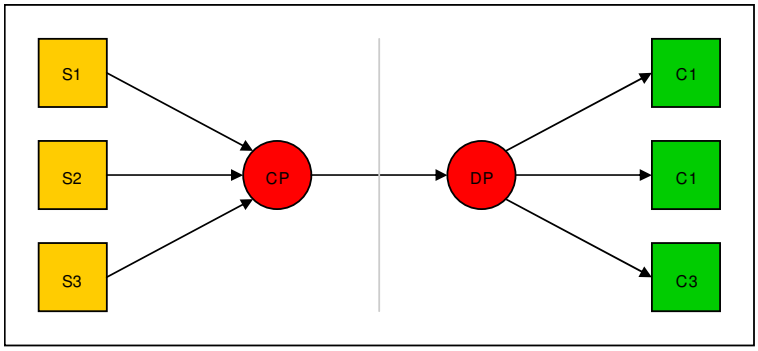

Figure 4.13 Consolidation and distribution points in different countries

Wherever quality and price permit, humanitarian organizations will try to purchase health care goods domestically in order to reduce transport costs and reduce lead times. In this case the distribution points in the recipient country will also serve as consolidation points (figure 4.14).

These national distribution centres combine the functions of consolidation, breaking bulk and combining health care goods to complete consignments to health care facilities (Jessop, D., and A. Morrison 1994, 3).

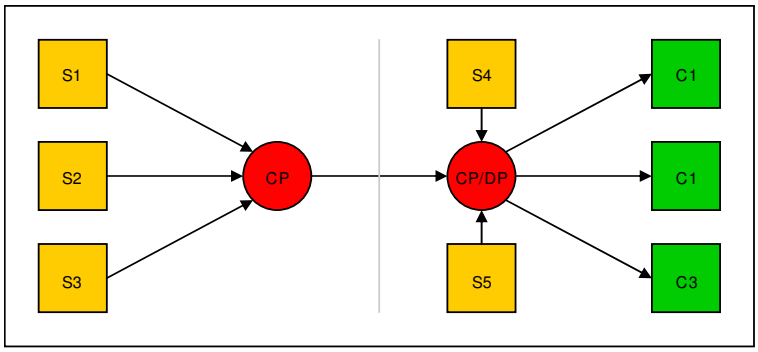

Figure 4.14 Distribution point as consolidation point for domestic purchase

In cases where high quality health care goods can be purchased in the vicinity of assisted health care facilities, local purchase reduces transport costs and allows direct delivery to the customer (figure 4.15). Local purchase is often an alternative for other essential goods such as food, fuel or cleaning materials. Finally on-site sourcing or production may be an option for water supply (sinking wells), electrical power generation with fuel driven generator sets as well as food production for example in a hospital bakery.

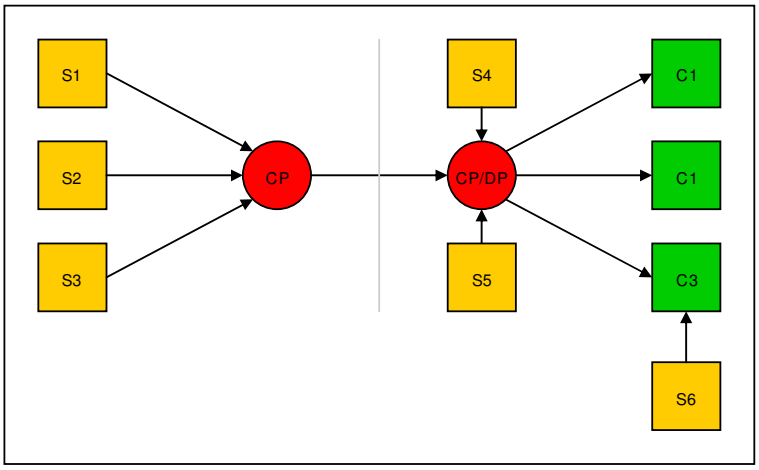

Figure 4.15 Facility network with local purchase

Especially where significant amounts of health care goods are purchased centrally at international distribution centres, regional distribution centres (RDC) allow reducing transport costs through consolidation and serve as distribution points for downstream national distribution centres (Gudehus, T. 1999, 24). Moreover regional distribution centres in countries with developed pharmaceutical markets can serve as consolidation points for domestically purchased health care goods (figure 4.16).

Regional distribution centres also reduce the dependency of national distribution centres from international distribution centres in terms of shortages, interruption of international transport as well as their limited capacity, especially in responding to several emergencies simultaneously. If all required health care goods are available in the country where the regional store is located, then the facility network corresponds to the facility network in figure 4.13.

International distribution centres must be located in developed markets in the vicinity of major suppliers of health care goods. Besides international distribution centres should be located near airports with an extensive international transport network as

well as a sea port for international shipment of large amounts of bulky and heavy goods.

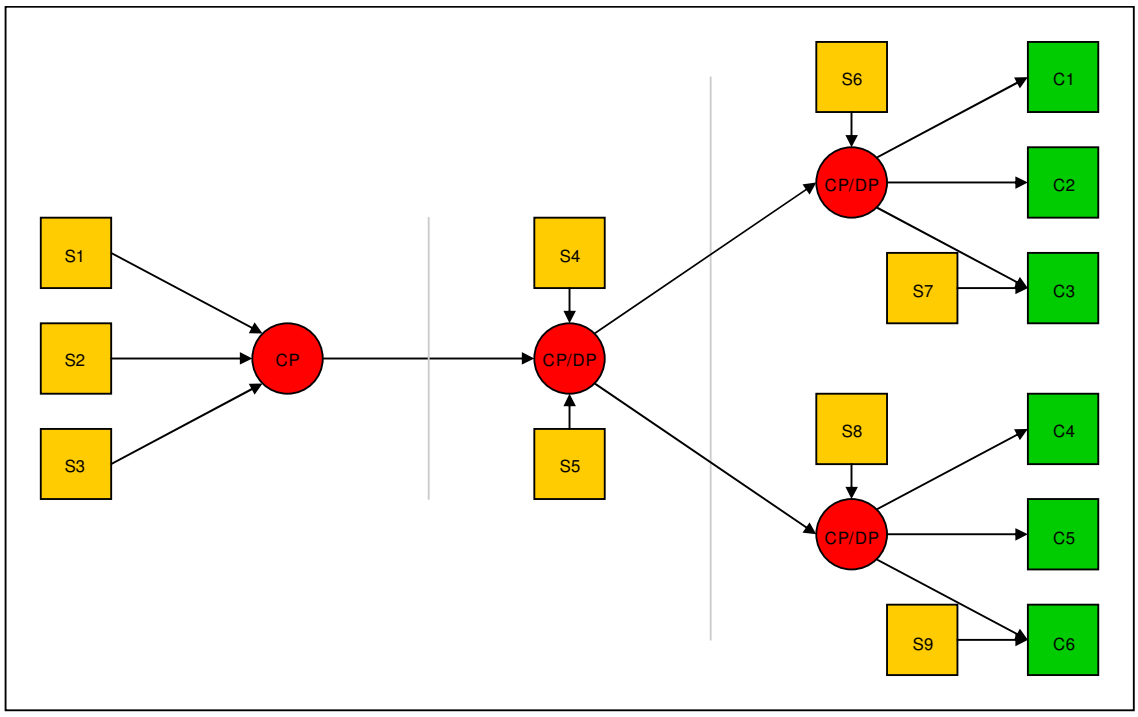

Figure 4.16 Facility network with regional distribution centre

Likewise regional distribution centres should be located in fairly developed markets with good transport connections to the countries in which humanitarian organizations are assisting health care facilities.

National distribution centres need to be located in the vicinity of international airports as well as along major transport routes. Where the major mode of transport is by road, national distribution centres must have good transport connections to ports of entry from neighbouring countries where consignments can be customs cleared.

Locating national distribution centres in national capitals is often a logical choice because of available infrastructure (PAHO 1983, 28) and since humanitarian organizations usually maintain offices there. However the location of national distribution centres should also minimize transport times to assisted health care facilities. Depending on the road infrastructure, front lines and the security situation, the routes with the shortest transport time may not necessarily coincide with the shortest distances.

Each storage facility must have sufficient capacity for storage as well as to manage the throughput required to serve all downstream storage facilities and customers. Moreover storage facilities should be selected or planned to allow future increases of storage capacity either by renting or building adjacent stores.

4.3.2 Site and facility selection

The macro perspective, which considers the geographical location of storage facilities, needs to be complemented by the micro perspective of the exact site location (Lambert, R.S., and J.R. Stock 1993, 311).

The exact location of a storage facility within a city or town does not change the global structure of the facility network. However the selection of sites and facilities which require significant investments for establishing and maintaining must also be considered as a long-term, strategic decision.

The primary concern must be to minimize safety and security risks for staff, assets and goods as well as the possibility that the security situation can deteriorate very quickly (Roberts, D.L. 2005, 121). Notifying conflict parties about the position of warehouses is an essential security measure which will avoid unintentional attacks and damage (Roberts, D.L. 2005, 74).

Apart from environmental risks such as flooding or earthquakes (Bickley, S. 2003, 50), the proximity to military installations such as barracks or checkpoints, must be avoided (Mayhew, B. 2004, 60). Moreover locations in the vicinity of facilities and infrastructure, for example airports, bridges or power stations, which are prone to become military targets, should be avoided (Roberts, D.L. 2005, 122). However these risks need to be balanced against the advantages of locating storage facilities near to main transport infrastructure such as inland ports and sea ports, airports, railheads or major road networks. In any case access to storage facilities with (heavy) vehicles must be possible during all seasons (UNHCR 2000, 259).

A single large building should be preferred to several smaller ones (UNHCR 2000, 259). Selected storage facilities must be large enough to accommodate the required storage space as well as ancillary facilities. The possibility of later extension inside or outside the facility must be considered during the planning stage (Bowersox, D.J., and D.J. Closs 1996, 408). Electricity supply, water (UNHCR 2000, 260), sewage and telecommunications facilities should be available. Sites must be well drained to prevent flooding during heavy rainfall (Dörner, G. (ed.) 1992, 18), surrounded by fences or walls to prevent unauthorized entry and furnished with security lighting (Bickley, S. 2003, 50).

Facilities must be structurally sound (PAHO 1983, 28) in order to provide the required protection of health care goods. Tents or prefabricated structures can be set up quickly, especially during the emergency phase (Ockwell, R. A. 1994, 444) but must be used only as temporary facilities (UNHCR 2000, 260) as they do not provide good protection of goods and do not allow cooling or heating. One-storey buildings should be preferred as they are easier to operate and require less sophisticated materials handling equipment. Openings of the building should be protected by blast walls (Roberts, D.L. 2005, 115) and a security shelter should be available to provide protection from small weapons, grenades and the effects of nearby explosions (Roberts, D.L. 2005, 110). If several suitable facilities are available, the final selection will be based on the cost for renting, leasing or purchasing facilities.

The selection of storage and materials handling systems is an important consideration of warehouse planning (Bowersox, D.J., and D.J. Closs 1996, 408).

4.3.3 Ownership of storage facilities

Humanitarian organizations have to take a strategic decision whether to in- or outsource establishing and operating storage facilities (Lambert, R.S., and J.R. Stock 1993, 268).

Public warehousing offers the advantage of not having to invest in establishing facilities, not having to carry the risk of its damage or destruction and the flexibility of changing the location of facilities quickly and at little cost. However humanitarian organizations have little control over stocks which is associated with a higher risk of

theft or confiscation. Public warehousing also makes humanitarian organizations dependent on commercial organizations which can jeopardize the reliability and consistency of supplying humanitarian assistance programmes. Handing over stocks to third parties in a country lacking legal security as well as the use of services by other customers who are implicated in the conflict may also pose security risks. Perhaps with the exception of large cities and ports, public warehouses which are owned and operated by private companies are unlikely to be available in less developed countries with poor infrastructure, especially in a conflict area.

Alternatively humanitarian organizations can operate private warehouses which they either own or lease. Since building facilities requires time, which is not available in emergencies, possible options are purchasing or leasing facilities. Ownership requires significant investment (Lambert, R.S., and J.R. Stock 1993, 406) which donors will be reluctant to fund, reduces flexibility of relocating facilities and carries the risk of confiscation, damage and destruction. However purchasing or even building facilities may be an option for international or regional distribution centres which are established in safe countries and are expected to be used at least for several years.

Consequently the most practical alternative is for humanitarian organizations to lease existing facilities including available storage and materials handling equipment, and operate them with their own staff. In this option facilities are available immediately, do not require large investments, the risk of damage and destruction remains with the owner and humanitarian organizations maintain full control over staff and stocks. Own storage capacities can be complemented by temporary use of public warehouses to accommodate sudden unexpected increases in stock levels (Bowersox, D.J., and D.J. Closs 1996, 403).

The acceptance of humanitarian organizations by the conflict parties should generally reduce the risks of attacks and confiscation. Humanitarian organizations maintain the flexibility of relocating facilities (Lambert, R.S., and J.R. Stock 1993, 272) if deteriorating security requires them to abandon a location or because the location of assisted health care facilities has changed. Storage of health care goods directly at the assisted heath care facility avoids having to establish and maintain a store.

A disadvantage of leasing storage facilities is that in case of reduction of humanitarian assistance and reduced needs for storage, capacities may remain unused without reducing fixed costs (Lambert, R.S., and J.R. Stock 1993, 274).

In some cases storage facilities may be offered by authorities or can be shared with other humanitarian organizations to reduce costs. Since long-term investment in sophisticated storage and materials handling equipment carries a high risk, simple storage systems such as shelving and floor pallets as well as mechanized materials handling equipment should be used. During the initial emergency phase and when stores are initially set up, floor pallets may be the only available storage equipment. However these are sufficient since initially the majority of health care goods will arrive in pre-packed kits which do not require put-away of a large number of individual items.

For stores and warehouses with high flows of goods the use of powered materials handling equipment can be considered, provided that availability of fuel, maintenance and repair services can be ensured.

4.3.4 Contingency plan

The ability to respond rapidly and effectively as soon as a humanitarian organization decides to provide assistance in a complex political emergency requires developing a

worldwide contingency plan in advance which can be implemented immediately (Center on International Cooperation 1999, 3).

Health professionals must determine what type of crises and the extent to which the respective humanitarian organization wants to respond to as well as which means they want to deploy and must determine the contents of emergency stocks. As pointed out in subchapter 4.1.4 mainly pre-packed kits should be stocked and used during the immediate emergency phase. It is then the responsibility of logistics managers to develop strategies which ensure that the required emergency stocks are permanently available (PAHO 1983, 20) can be delivered rapidly to any location where they are required. Positioning of contingency stocks follows the push-pull principle. Contingency stocks are positioned throughout the supply network according to a forecast (push) and "pulled" from contingency stocks according to actual demand at health care facilities.

Health programme managers will also have to assess emerging complex political emergencies and decide when to commence humanitarian assistance. Humanitarian assistance programmes may not be implemented immediately when a crisis emerges because of lack of funding, because affected populations can cope with the crisis by relying on their own means or because the situation is considered as too dangerous for intervening.

Contingency plans are required during different phases of crises (WFP 2001, 2). The permanent contingency plan which prepares for crises which are not foreseeable will be called emergency preparedness plan. The contingency plan which is developed in preparation of an expected or imminent emergency and before the humanitarian organization commences any programmes in a specific region or country will be called an emergency intervention plan. Contingency plans may comprise several scenarios which are derived from various assumptions concerning political developments, the type of humanitarian crises as well as the impact on the affected populations (IASC 2001, 7).

Finally contingency plans which are maintained throughout the duration of ongoing humanitarian assistance programmes (WFP 2001, 5), especially in protracted armed conflicts, and which are intended to respond to unexpected events will be called emergency response plans.

Providing humanitarian assistance to health care facilities quickly requires, among others, establishing and maintaining emergency stocks (WHO 1996, 17). Permanently maintaining stocks will avoid any delays for purchasing health care goods when they are urgently needed and hedge against the risk of stockouts at suppliers caused by high demand for the same goods from other humanitarian organizations. On the other hand maintaining emergency stocks incurs costs and donors are often reluctant to fund them (Center on International Cooperation 1999, 4).

In order to minimize costs for storage of stocks which might not be used for a long time, emergency stocks should be stocked in storage facilities which are maintained for serving ongoing humanitarian assistance programmes. Within the existing storage facility network a decision must be taken at what level emergency stocks are held.

Emergency stocks can be stored centrally, regionally, nationally, locally as well as inside health care facilities. Compared to decentralized (downstream) emergency stocks, keeping emergency stocks upstream allows to reduce global emergency stock levels and increase turnover of stocks but increases lead time and therefore increases response time (Center on International Cooperation 1999, 5). Establishing emergency stocks in the country where a crisis is anticipated avoids delays caused by importation or congestion of ports after a crisis has emerged (PAHO 1983, 42). On the other hand,

unlike regional emergency stocks, emergency stocks which have already been imported into a country suffering from chronic lack of health care services, may be difficult to export again for use in another programme abroad if they are not needed during the crisis.

A compromise to balance the overall emergency stocks and responsiveness is to keep stocks for emergency preparedness centrally and regionally and move them downstream to regional or national distribution centres when a crisis is anticipated or imminent. This strategy will allow using cheaper means of transport (Perrin, P. 1996, 423), such as scheduled flights by commercial airlines, in preparation for a crisis rather than having to rely on expensive transport, such as charter flights, to respond when the crisis has already emerged. Moreover, depending on the distances and geography, regional and national distribution centres will more often allow using road transport for distributing emergency stocks in case they are needed. A further advantage is that available infrastructure can be assessed and tested before humanitarian assistance programmes commence. Difficulties encountered with third party logistics suppliers, unsuitable infrastructure such as airports or delays for customs clearance in certain ports allow making changes before humanitarian assistance goods are requested by end-users. Stocks which are not used for responding to the emergency can either be used for ongoing humanitarian assistance programmes or shifted back upstream and maintained for the emergency preparedness plan.

The worldwide value of emergency stocks as well as the transport costs in case of an emergency can be reduced by storing bulky goods with low value density such as infusions or dressing material further downstream while stocking small items with high value density such as surgical instruments, sutures or diagnostic tests centrally.

Another means of balancing global stock values and responsiveness is to maintain emergency stocks of different sizes throughout the supply network. Immediate needs after an emergency need to be covered from local resources since it takes time to assess needs, transmit them upstream, prepare and transport health care goods (PAHO 1983, 5). Every health care facility should be prepared to cope with a large number of casualties and have sufficient stocks for the first few days (Perrin, P. 1996, 230). These emergency stocks at health care facilities allow sufficient time for deliveries from national distribution centres to arrive. The later in turn would maintain stocks only to cover emergency needs for a few days until stocks can be replenished from regional or international distribution centres. This strategy also avoids the problems which may be caused by delays for customs clearance.

Another strategic decision concerns the ownership of emergency stocks. Commercial consignment stocks are stocked and turned over by suppliers (Center on International Cooperation 1999, 8) but available in contractually agreed quantities. This arrangement avoids expenses for storage of emergency stocks which might not be used for months and also avoids expiry of goods in stock. However contracted suppliers must be reliable in order to ensure that contingency stocks are not sold to other humanitarian organizations in the event of complex political emergencies and are therefore no longer available.

Expiry of emergency stocks can be avoided by including the quantities of health care goods required for emergencies in the reorder level for ongoing humanitarian assistance programmes (PAHO 1983, 22). However when overall stock levels drop to predetermined emergency stock levels, distribution of stock on hand for covering demand of ongoing programmes must be suspended until replenishment in order to ensure that emergency stocks are available at all times.

Emergency stocks which are not commonly used for distribution to ongoing humanitarian assistance programmes need to be established separately as designated stocks (PAHO 1983, 22).

In order to avoid duplications, contingency plans should also consider emergency stocks of other humanitarian organizations, governments or health care facilities (PAHO 1983, 26). Overall emergency stock levels across humanitarian organizations can be decreased by dividing responsibilities for different contingencies such as a cholera outbreak (Hanquet, G. (ed.) 1997, 147), need for a mass vaccination campaign or care of war-wounded among different humanitarian organizations.

4.3.5 Facility network design strategy

The overall facility design strategy (figure 4.17) must aim at providing the required service within given constraints (Gudehus, T. 1999, 13) while at the same time minimizing safety and security risks as well as minimizing overall transport and storage costs.

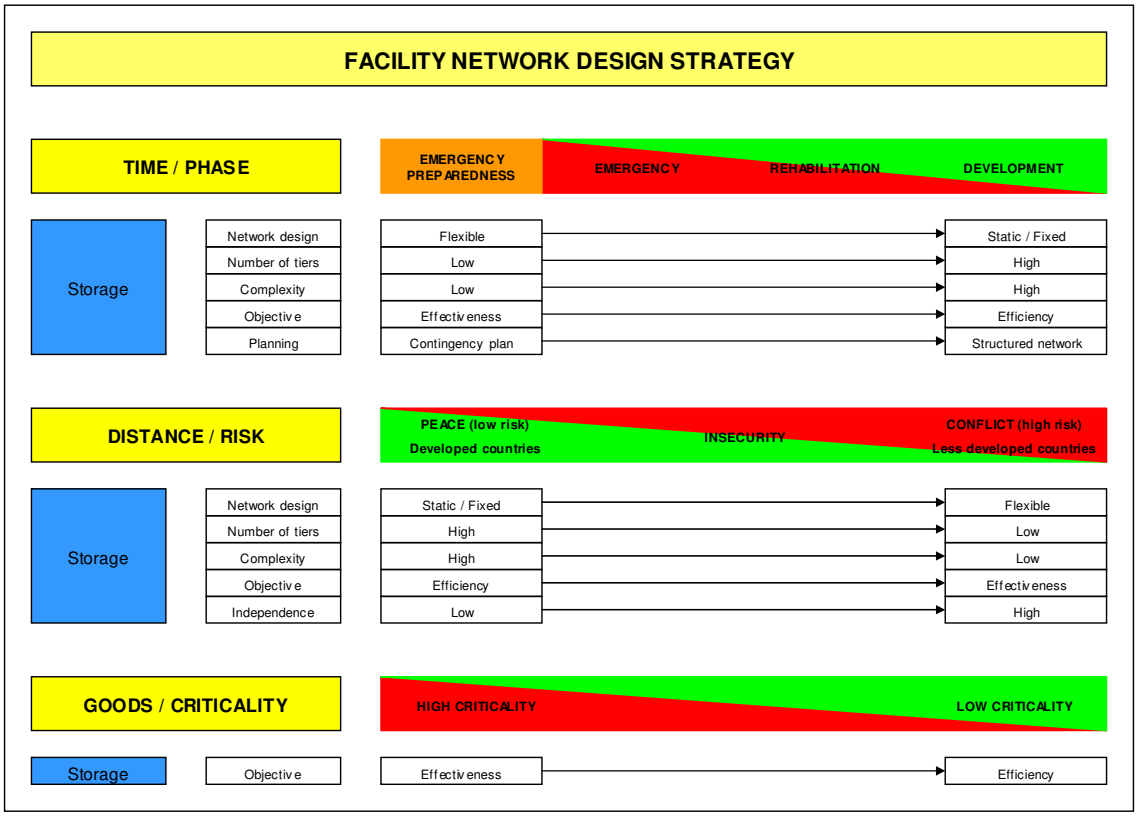

Figure 4.17 Facility network design strategy

Generally facility networks can be temporary and flexible or permanent (Gudehus, T. 1999, 37). The pre-emergency contingency plan requires a highly flexible design in order to be able to respond quickly to any complex political emergency anywhere in the world. Logistics managers must consider the trade-off between costs for additional storage facilities and responsiveness (Chopra, S., and P. Meindl 2004, 56). The facility network design may include storage facilities which are poorly utilized for long periods of time but are indispensable for a rapid response. Emergency response plans still need to be flexible to allow adapting to possible changes in entry points into the country as well as to changing programmes within the conflict area.

After the acute emergency phase and once the humanitarian organization has decided on their assistance strategy and the locations of assisted health care facilities have been determined, a more efficient facility network can be tailored to known needs. In the development phase facility network designs can remain more or less fixed since development assistance programmes are planned to last several years.

Global networks can combine permanent and flexible networks at different levels (Gudehus, T. 1999, 38). Upstream in the supply network, humanitarian organizations can use fixed commercial networks such as the networks of international air carriers and airports while building a flexible network with their own means downstream in the country where humanitarian assistance is provided (Bowersox, D.J., and D.J. Closs 1996, 403).

At the onset of a complex political emergency there may not be sufficient time to thoroughly assess the infrastructure of a country or area and to find suitable storage facilities. Consequently humanitarian organizations will resort to direct deliveries from international or regional distribution centres to assisted health care facilities relying mainly on air transport. As soon as the security situation permits and suitable storage facilities have been found, national distribution centres can be set up. The increase in number of tiers of the facility network then allows benefiting from transport economies as well as resorting to cheaper surface transport.

During the emergency phase the main objective is to provide urgently needed health care goods to assisted health care facilities rapidly and effectively. Consequently the facility network design must be simple, relying mainly on direct deliveries. Once the immediate needs are covered and a more complex facility network has been established, logistic managers can focus on reducing costs and increasing the efficiency of the supply network.

During the emergency preparedness phase the context of future emergencies is not known and planning must consider all possible crises the humanitarian organization intends to respond to. During the emergency phase, the planning of logistics managers will have to make do with incomplete information about the location, context of the respective complex political emergency and the infrastructure in the conflict area. Once a thorough logistical assessment has been carried out and health programme managers have determined their assistance strategy (UNDAC 2000, chapter L, 2), a structured facility network which is tailored specifically to programme needs can be developed and established.

Even after the immediate emergency phase has ended, in protracted complex political emergencies, facility networks within a conflict area must remain highly flexible in order to quickly respond to changes in the security situation as well as changing needs of the affected population. For example storage facilities may need to be evacuated if the location is attacked and sudden movements of large populations will require quickly shifting assistance to other health care facilities. Consequently the facility network must remain flexible so it can be tailored to changing needs.

Conversely, the facility network design in safe areas such as adjacent areas or countries can be more static and focus on efficiency of the network.

Lack of security requires limiting the number of tiers and storage facilities within the conflict area in order to reduce the risk of confiscation, blocking, damage and destruction of storage facilities and stocks.

Flexibility of facility networks also implies that the number of tiers is kept as low as possible. A complex facility network within the conflict area would incur considerable costs for dismantling, moving and re-establishing storage facilities.

Since generally management of storage facilities inside a conflict area is more difficult, their complexity should be kept as low as possible. Consequently buildings, infrastructure, storage and materials handling equipment, utilities, information systems and human resources management should be kept as simple as possible.

Within the conflict area the main objective must be to ensure that health care goods reach assisted health care facilities on time even if this requires expensive transport. Outside the conflict area overall supply chain management can focus on efficiency for example by establishing additional storage facilities and benefiting from transport economies and using cheaper modes of transport.

Due to the overall lack of security, humanitarian organizations must be in control of storage facilities inside conflict areas. This requires having full control over (leased) storage facilities and premises as well as their security, hiring and managing staff and operating storage facilities. In order to avoid interference and possible security risks, storage facilities should be used only by the respective humanitarian organization or shared with other humanitarian organizations provided they remain neutral in the conflict.

Conversely ownership and operations of storage facilities outside the conflict area may be shared with other users or outsourced, for example relying on facilities of freight forwarders or public warehouses.

The design of facility networks for highly critical health care goods must ensure effectiveness of provision to health care facilities even if high costs are incurred, for example by establishing more complex facility networks. Conversely logistics managers can focus on increasing efficiency of the facility network for health care goods with low criticality.

4.4 Physical distribution

Physical distribution, as the dynamic element of the supply network, enables the physical flow of goods from manufacturers to recipients with or without passing through storage facilities.

4.4.1 Physical distribution channels

Physical distribution channels are collections of cooperating organizations which organize and manage the flow of goods from the manufacturer to the end-user as well as intermediate storage throughout the supply network (Lambert, R.S., and J.R. Stock 1993, 72).

Humanitarian assistance goods can in principle flow along any path through a supply network according to tactical and operational decisions, for example depending on the recipients, security constraints or characteristics of health care goods.

However since the facility network design and the selection of physical distribution channels are interdependent, logistics managers must also take some strategic decisions concerning the structure of physical distribution channels. Different modes of transport may be used for the same physical distribution channel at different tiers of the supply network, for the same transport leg at different times or for consignments with different characteristics.

Humanitarian organizations need to take a strategic decision whether goods flow through commercial or humanitarian networks (see figure 4.18). Commercial suppliers as well as humanitarian organizations may decide on a tactical and operational level

whether distribution services are in- or outsourced. Consequently the decision is related to the question which organization controls the flow of goods.

Since both networks are unlikely to extend from the manufacturer up to the end-user, in most cases a combination of both networks will be necessary. Direct pickup of purchased goods by humanitarian organization at the manufacturer will be an exception. Likewise only in exceptional cases will the supplier be able to deliver purchased goods directly to assisted health care facility. Consequently the strategic decision is to what extent humanitarian organizations generally want to rely on supplier networks and at what stage goods should pass from one network to the other.

The use of supplier networks has several advantages. Supply networks of manufacturers or intermediaries are already established and immediately available while humanitarian organizations might have to build the network to link manufacturers and end-users. At least upstream in the supply network, suppliers will be able to benefit from transport economies and therefore operate more cost-efficiently than humanitarian organizations.

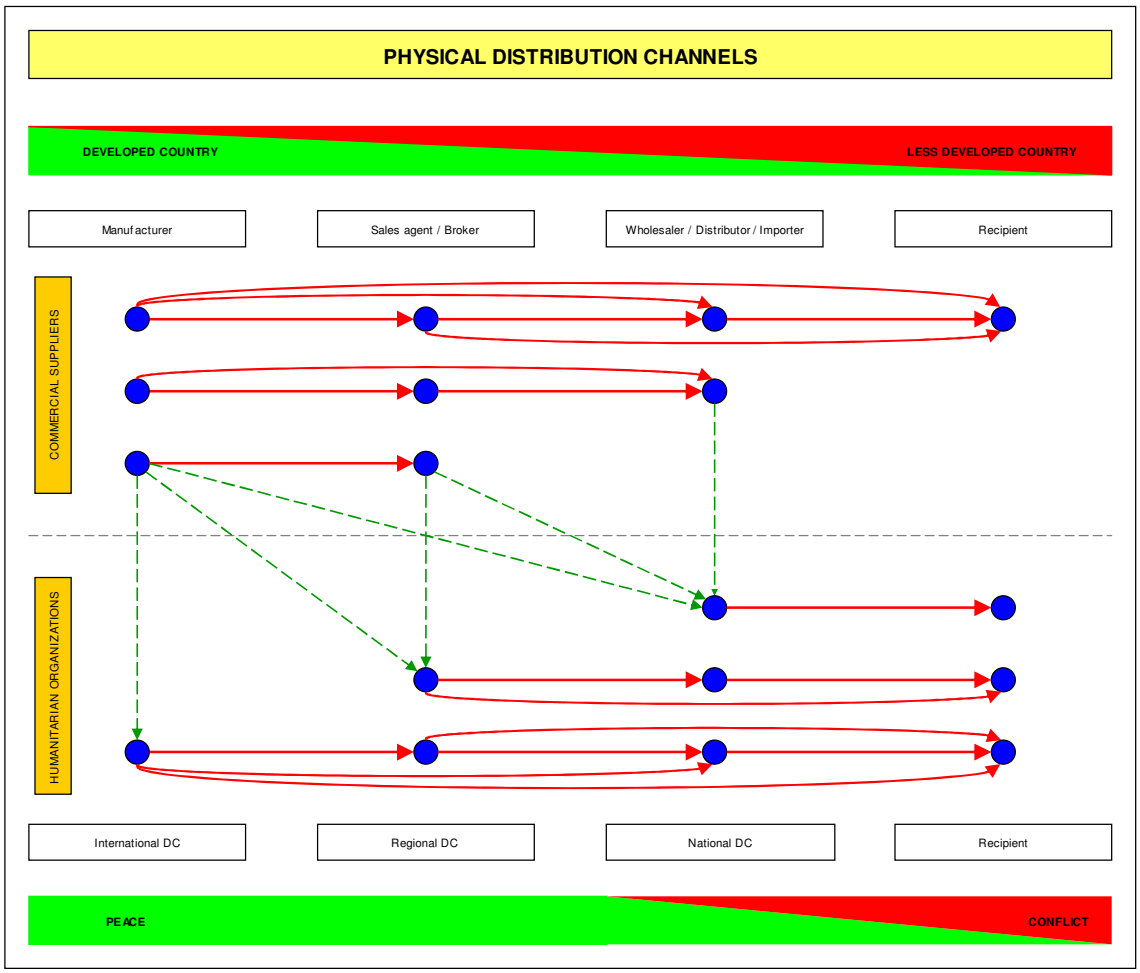

Figure 4.18 Physical distribution channels

The use of supplier networks reduces the risk of losses or damage of goods up to delivery to a facility managed by the humanitarian organization.

Shipment and storage of some health care goods, such as equipment susceptible to damage, heavy or bulky equipment or dangerous goods which require special packing, can be handled better by experienced suppliers.

Finally resources needed to track and trace shipments are reduced for humanitarian organizations as the supplier is fully in charge until goods are delivered to a facility managed by the humanitarian organization.

On the other hand using supplier networks leads to dependency on their services and especially lead times. Moreover following up the order status as well as the current location of goods is likely to more difficult than if distribution is managed by the humanitarian organization.

The control of the flow of goods by humanitarian organizations reduces the risk of adulteration or introduction of counterfeit products between the manufacturer and the recipient.

Obviously humanitarian organizations must resort to their own supply network where suppliers have not established their own networks. Suppliers are less likely to maintain their own networks in less developed countries with unattractive markets and will not maintain or suspend distribution of goods in countries or areas where security is poor.

Finally, humanitarian organizations are likely to benefit from transport economies downstream towards and especially inside the conflict area, especially if they provide a range of other humanitarian assistance goods to the affected population.

4.4.2 Contingency plan

The contingency plan developed in chapter 4.3.4 must be complemented by provisions to ensure immediate availability of suitable transport (Center on International Cooperation 1999, 8). The capacity must be sufficiently large to allow distribution of essential health care goods as soon as humanitarian organizations decide to commence assistance. In case of crises which involve a large number of humanitarian organizations competition for transport resources may lead to a shortage of transport capacities, especially large long distance charter aircraft, and significantly increase prices.

Humanitarian organizations can take the strategic decision to preposition their own transport resources such as trucks and boats which will ensure availability in case of a crisis but on the other hand incur significant costs for maintenance and storage.

The emergency preparedness plan can compromise transport resources such as vehicles which are operational and prepositioned at strategic locations near international airports and can be shipped to any crisis region at short notice. Prepositioning only at international distribution centres allows minimizing the value of valuable resources, which may remain unused for significant periods of time, but entails longer lead times and higher costs for deployment compared to prepositioning at regional or even national distribution centres.

An alternative to storing and maintaining idle transport resources is to develop regional plans for withdrawing part of the transport fleet used in ongoing programmes and shifting vehicles to another conflict area at short notice.

Another possibility to avoid valuable resources remaining idle is to conclude contracts with commercial air carriers for chartering aircraft or with manufacturers to guarantee immediate availability of new vehicles or boats. Such contracts also avoid delays caused by sourcing and tendering for transport resources in an emergency especially if they occur during public holidays. Arrangements can also be made with international air carriers which operate worldwide and can guarantee transport at least up to any international airport.

4.4.3 Mode of transport

The mode of transport will depend on the context, situation as well as on the type of health care goods. Nevertheless some strategic decisions which apply to any humanitarian assistance programme can be taken by humanitarian organizations.

Air transport will be the only reasonable means of transport of humanitarian assistance goods over great distances in emergencies as well as for expediting urgent shipments, while slower surface transport can be used once stocks have been established and demand is stable. However humanitarian organizations may decide to use only air transport, wherever available, for drug products in order to minimize exposure to potentially adverse environmental conditions or for health care equipment in order to reduce the probability of damage. Faster air transport may also be selected in order to shorten lead times which in turn allows to reduce safety stocks and therefore reduce channel inventories and overall storage costs (Chopra, S., and P. Meindl 2004, 427). Alternatively humanitarian organizations may decide to use slower surface transport for ongoing humanitarian assistance programmes for health care goods which are bulky, have low value densities or very predictable demand, even for international distribution (European Commission 1998d, 70). As a consequence larger capacities at distribution centres will be need to increase safety stock levels.

Humanitarian organizations may also take a strategic decision to use air transport within a conflict area if it proves to be safer than surface transport even if overall transport costs increase significantly.

Since higher levels of responsiveness are associated with higher costs (Chopra, S., and P. Meindl 2004, 36), health programme managers must make a strategic choice concerning the desired responsiveness of physical distribution systems in general.

A strategic decision is also necessary to establish a "fast track" for shipping urgently needed goods to customers, for example by concluding contracts with package carriers offering worldwide services while using routine shipments with slower means of transport for routine orders.

4.4.4 Ownership of transport means

Like commercial organizations, humanitarian organizations can use private, contract or common carriage (Bowersox, D.J., and D.J. Closs 1996, 29) for distribution of humanitarian assistance goods within the supply network. Moreover humanitarian organizations may also be able to use transport capacities of other humanitarian organizations, authorities in the host country as well as domestic or foreign armed forces (European Commission 1998d, 66).

While many decisions concerning transport management are taken on a tactical or operational level, the use of own resources rather than outsourcing transport services requires a far reaching strategic decision which must be taken before humanitarian assistance programmes commence. Humanitarian organizations may rely entirely on their own transport resources, complement them with commercial resources or rely entirely on commercial transport capacities. An overview of criteria for the ownership of means of transport is shown in figure 4.19.

Transport assets such as vehicles, ships and aircraft are expensive, require careful selection of the most suitable equipment and obtaining funds for purchasing these assets. Operating vehicle fleets and especially aircraft requires skilled and experienced staff such as vehicle fleet or air operations managers. Moreover operating vehicle

fleets depends on the capacity to provide maintenance and repair services in the field and to provide a wide range of replacement parts to workshops in the field.

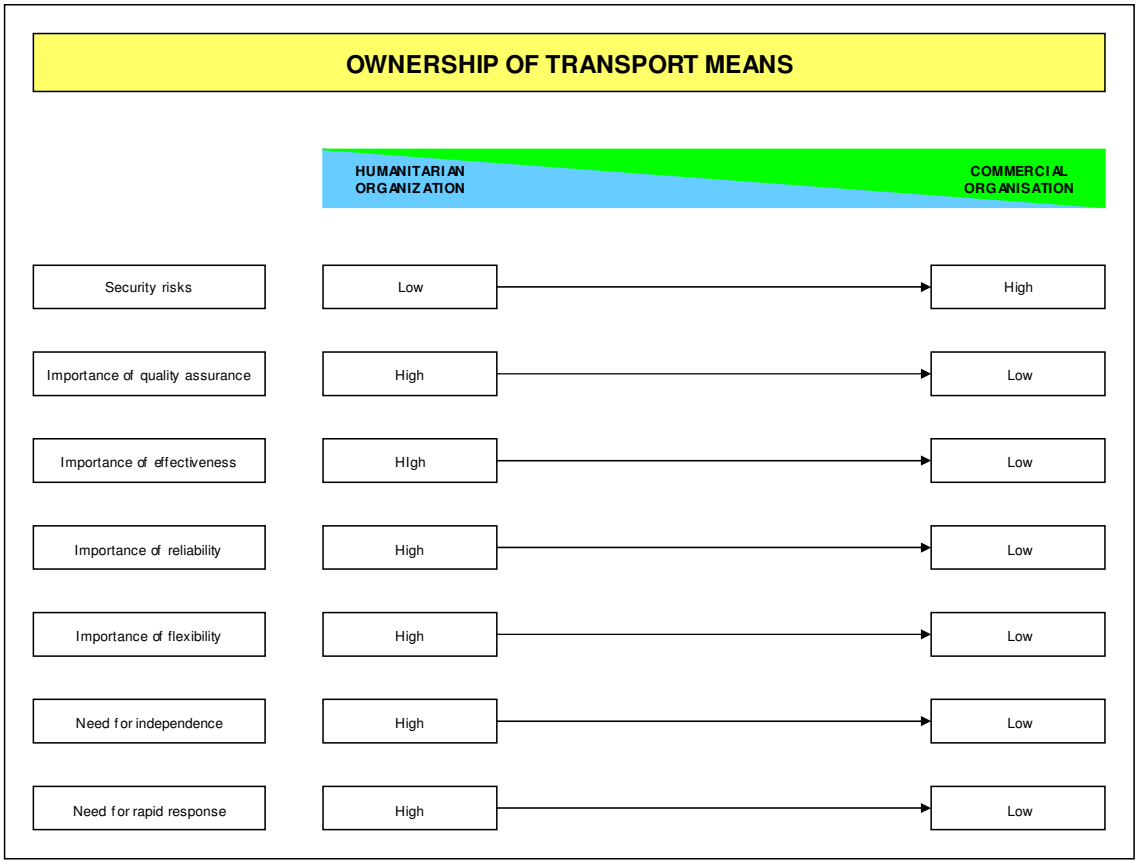

Figure 4.19 Criteria for ownership of transport means

The decision on operating means of transport by humanitarian organizations is also linked to the strategic decision whether logistics and supply chain management in conflict areas is considered as a core competency. Increasing competition among humanitarian organizations as well as pressure by donors requires humanitarian organizations to concentrate available resources on their core activities and core competencies (European Commission 1998d, 25). Areas in which humanitarian organizations do not have any comparative advantage over other organizations which can provide the same service should be outsourced (European Commission 1998d, 27).

Commercial organizations have greater experience and expertise in transport management than humanitarian organizations. However they generally lack the willingness, experience and capacity to operate in conflict areas or their vicinity.

Outsourcing transport services makes investment in expensive assets, which donor may be unwilling to fund (European Commission 1998d, 69), unnecessary and generally reduces the complexity of supply chain management. Outsourcing of transport also allows calculating all related costs exactly.

Generally commercial carriers, who specialize on transport service and have more experience than humanitarian organizations, can operate more cost-efficiently. Especially for international transport and transport along major routes commercial carriers can benefit from transport economies by consolidating consignments from several humanitarian organization or combining them with commercial consignments.

The possibility of shipping smaller consignments to health care facilities more frequently allows delivering goods whenever needs arise rather than having to rely on less frequent scheduled transportation of consolidated consignments of humanitarian assistance goods.

Domestic carriers will be more familiar with legislation, regulations as well as road and weather conditions in the country. Moreover humanitarian assistance goods flow almost entirely in one direction while commercial carriers may be able to increase their vehicle utilization through back-hauls (Bowersox, D.J., and D.J. Closs 1996, 367).

Commercial carriers offering tracking and tracing services allow monitoring the location of goods closely without humanitarian organizations having to implement and maintain their own information system (European Commission 1998d, 74).

In-house transport resources have the advantage of not affecting operations by shortages of commercial transport capacities and subsequent (unreasonable) price increases. Control over transported goods is also higher with in-house transport. Because of the lack of legal security humanitarian organizations are unlikely to be able to retrieve goods stolen during transport.

Moreover humanitarian organizations may have cost advantages through tax exemptions for importing vehicles into the country as well as for purchasing fuel on the domestic market. Finally in-house resources are not subject to the security constraints of commercial organizations. If humanitarian organizations deem an area safe enough to provide assistance, then transport means can be operated in the same area.

The first consideration is minimizing safety and security risks to staff, assets and humanitarian assistance goods. Outsourcing of distribution services to other commercial, humanitarian or military organizations has the advantage of avoiding the risk of damage or loss of expensive transport resources. However the risk is transferred only partially as humanitarian organizations will be charged higher transport rates to cover the higher cost of insurance.

However since commercial carriers and the armed forces may be less accepted in the conflict area than humanitarian organizations, the former may be prone to being denied access or becoming a target. This not only increases the risk for staff and assets but also jeopardizes the effectiveness of humanitarian assistance programmes. On the other hand in some cases where humanitarian organizations are being seen as partial, they may encounter greater risks than commercial organizations.

Although humanitarian organizations may prefer to outsource transport in areas with high security, they may be unable where commercial organizations are not available or unwilling to operate.

Maintaining the quality of health care goods along the entire supply chain requires the capacity to transport certain types of goods such as cold chain items or sensitive health care equipment under certain conditions. Wherever commercial carriers with the necessary expertise are not available, humanitarian organizations will need to maintain their own capacities.

Entirely outsourcing transport services carries the risk of interrupting humanitarian assistance programmes at any time without prior notice. Commercial carriers may be unavailable, unwilling to operate in the conflict area or refused permission for operating by authorities or conflict parties. Other humanitarian or military organizations may not be able or willing to provide transport capacities to humanitarian organizations or lack sufficient capacity.

Available commercial carriers may not comply with international standards, especially concerning air worthiness of aircraft, and therefore not be considered safe enough to provide transportation services especially for staff and patients.

Since humanitarian organizations must ensure continued and uninterrupted assistance to health care facilities, reliability and consistency of transport services are essential. Consistency, which can be considered as the most important characteristic of the quality of transportation services (Bowersox, D.J., and D.J. Closs 1996, 29) requires ensuring minimum variation in transport lead times.

In order to ensure effectiveness as well as reliability and consistency, humanitarian organizations need to be able to quickly resort to their own means of transport if commercial carriers suspend their services or reduce their capacities.

Transport resources owned by humanitarian organizations allow a maximum of flexibility and responsiveness as transport resources and capacities can be quickly adapted to the needs of humanitarian assistance programmes. Commercial carriers serving other customers may not be able to adjust their services immediately or lack additional capacities when they are needed.

Humanitarian organizations may be unable to make use of commercial or military transport resources without compromising their independence towards the conflict parties. The decision to accept services of armed forces is highly political and will also depend on donors funding humanitarian organizations (European Commission 1998d, 71). Cooperation can lead to the association of humanitarian organizations with political and military objectives of armed forces and increase insecurity for humanitarian workers (ECHO 2004, 72). Some humanitarian organizations believe armed forces should not be involved in provision of humanitarian assistance at all, others that humanitarian organizations should resort to their assistance if they are overwhelmed (Mayhew, B 2004, 23). Likewise the sharing of transport resources with other humanitarian organizations may have strong political implications, especially if humanitarian organizations providing transport services do not strictly respect their neutrality towards all conflict parties. Cooperation with one party to the conflict may make it impossible to safely operate within the area under control of an opposing party to the conflict (ECHO 2004, 73) and therefore erode impartiality in the conflict.

Dependence on limited commercial transport capacities carries the risk of interruption of transport services if commercial carriers are no longer permitted to operate or suspend their services because they are not willing to take the risk. Moreover humanitarian organizations will be affected by shortages in case overall demand for transport resources increases, for example when the number of humanitarian organizations requiring transport in an area increases (European Commission 1998d, 68).

By managing their own transport services, humanitarian organizations not only avoid dependency on commercial carriers, but can also exert closer control over routing and scheduling as well as over the transported goods and reduce the risk of theft. Moreover commercial carriers carry the danger of compromising the neutrality of humanitarian organizations by transporting weapons or drugs.

Sourcing and purchasing transport services requires knowledge of the market as well as time for obtaining, comparing and selecting quotations. Such delays can be avoided by maintaining transport resources in-house which can be mobilized or re-directed at short notice.

In-house transport services facilitate recording the exact time and location of distributions of humanitarian assistance goods which are required for donor reporting.

Humanitarian organizations need to take a strategic decision whether they want to rely entirely on their own means of transport or make use of commercial transport services, transport offered by other humanitarian organizations, governments or armed forces. Sharing transport capacities can significantly reduce transport costs but may lead to dependencies and reduce control over the physical distribution system. Besides conflict parties may consider cooperation with other organizations, which may or may not take sides in the conflict, as contravening the humanitarian organizations' impartiality and neutrality.

4.4.5 Physical distribution strategy

During the initial emergency phase the main objectives are to respond quickly to demand (PAHO 2001, 131) and to ensure required health care goods actually arrive at the assisted health care facilities (figure 4.20).

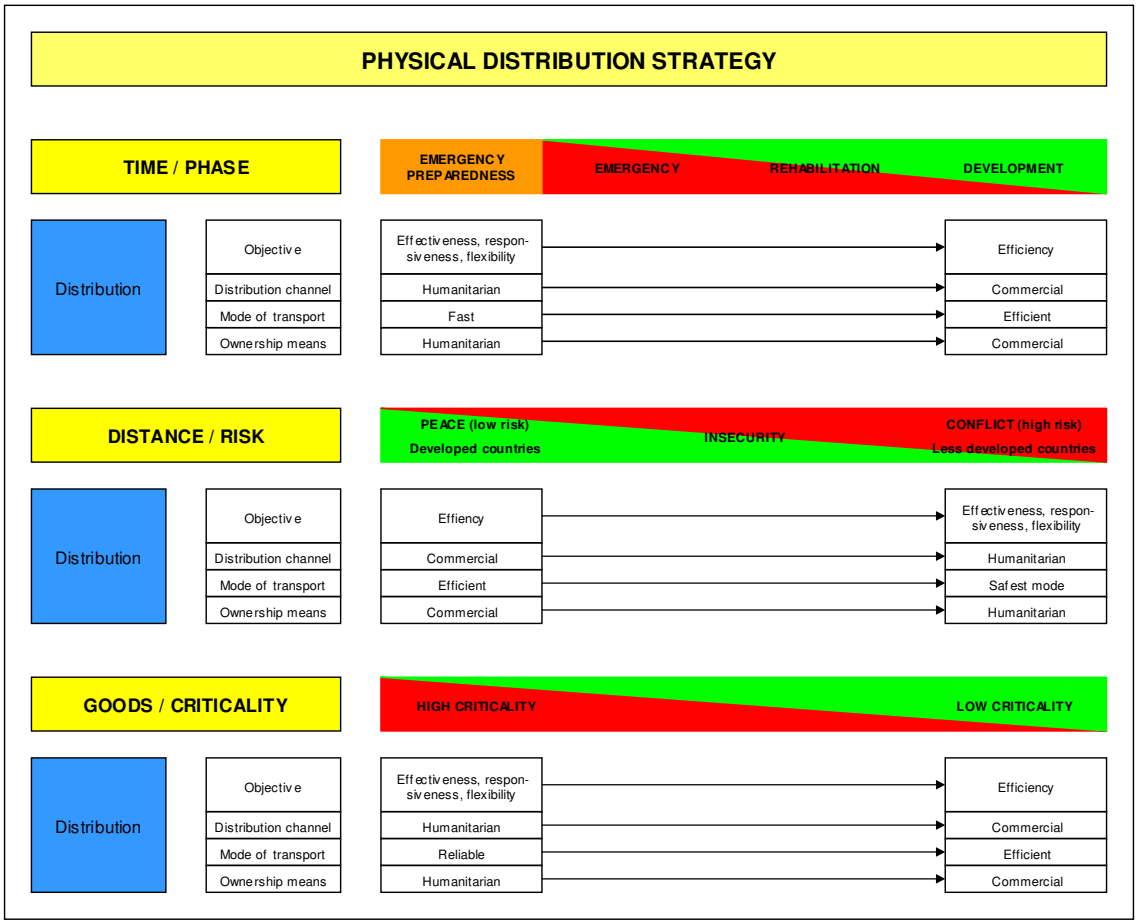

Figure 4.20 Physical distribution strategy

In order to avoid dependency and possible interruption of assistance, humanitarian organizations will utilize their own distribution channels and use their own means of transport, at least near or in the conflict area. When the security situation improves and commercial suppliers and carriers restore their services, humanitarian organizations can resort to using the more efficient commercial distribution channels as well as commercial carriers.

In order to minimize lead times, humanitarian organizations will favour shipments from available sources of health care goods directly to assisted health care facilities.

Once stocks have been established along the supply network, humanitarian assistance programmes can be supplied from their next upstream store, minimizing lead time as well as transport costs.

During the emergency phase the fastest mode of transport will be selected even if high costs are incurred. Transport management in terms of mode and means of transport as well as transport routes must be highly flexible to allow quick reaction to changes of the situation as well as changing needs. Once the humanitarian assistance programmes as well as the supporting supply network and stocks have been established, distribution management can focus on increasing efficiency and reducing overall distribution costs.

While humanitarian organizations can focus on efficiency of physical distribution to the country or area where humanitarian assistance is provided, they must again focus on effectiveness, responsiveness and flexibility within the crises area.

Commercial distribution channels and carriers can be used as far towards the conflict region, country or area as commercial activities are not affected, impeded or interrupted by the conflict. Near and inside the conflict area humanitarian organizations will rely on their own distribution channels to ensure that provision of essential humanitarian assistance goods is reliable and not interrupted.

Within the conflict area humanitarian organizations must use the safest mode of transport while using the most efficient mode of transport outside the conflict area.

For essential and critically important health care goods, the priority must be to ensure reliable delivery to assisted health care facilities while distribution management can focus on efficiency for non-critical and substitutable health care goods.

Humanitarian organizations will also want to closely control the distribution of critical and valuable health care goods directly to assisted health care facilities and therefore prefer using their own distribution channels and transport means.

4.5 Customer service

Although not for the purpose of gaining profits (Chopra, S., and P. Meindl 2004, 5) or competitive advantage (Harrison, A., and R. van Hoek 2002, 209), customer satisfaction as the global objective of supply chain management (Govil, M., and J.M. Proth 2002, 67) also applies to humanitarian organizations. Ultimately customer satisfaction lies in the prevention or reduction of suffering of people receiving assistance, achieved through provision of high quality health care goods. Satisfaction of health care professionals receiving and applying health care goods, of health programme managers as well as donors also requires some consideration.

Development of a customer service policy, determining required services as well as defining customer service levels are essential for planning and allocating required logistical resources and capacities (Lambert, R.S., and J.R. Stock 1993, 637). Defining customer service objectives is necessary for measuring and monitoring performance, focusing resources on defined objectives as well as for a coherent approach of all staff and departments in providing services.

4.5.1 Development of a customer service policy

In order to plan their assistance, health programme managers need to know what kind as well as what level of services they can expect.

Corporate mission statements which, among others, determine products and services provided, customers as well as geographical markets serve as basis for developing logistics mission statements (Lambert, R.S., and J.R. Stock 1993, 637)

Development of a customer service policy must start by identifying elements of service which are most important to customers (Rushton, A., J. Oxley, and Ph. Croucher 2000, 39) such as quality of health care goods, stock availability and lead times. Since eventually patients receiving health care services are the ultimate customers, but rarely have the knowledge and opportunity to select appropriate health care goods, in practice immediate customers are health programme managers as well as health care professionals.

Determining the relative significance and minimum required service levels for each customer service factor (Rushton, A., J. Oxley, and Ph. Croucher 2000, 40) allows monitoring service levels and ensuring that customer expectations are met.

Depending on the context and constraints, customer service requirements and required service levels may need to be tailored to the needs of individual humanitarian assistance programmes as well as the importance of individual goods.

Like in commercial organizations (Rushton, A., J. Oxley, and Ph. Croucher 2000, 40), humanitarian assistance programme managers need to carefully balance desired services as well as service levels with the costs of providing these services.

4.5.2 Customer service elements

Elements of customer service can be categorized into pre-transaction, transaction and post-transaction elements (Harrison, A., and R. van Hoek 2002, 36).

The customer service policy as a pre-transactional customer service element, should be stated in writing and made available and distributed to customers (Lambert, R.S., and J.R. Stock 1993, 114), health programme managers as well as assisted health care facilities.

A single order contact point should be established which is easily accessible at any time (Christopher, M. 1998, 41), including after-hours as well as during holidays and placing orders should be as simple and convenient as possible.

Logistics service must be as flexible as possible to accommodate unexpected customer requests (Bowersox, D.J., and D.J. Closs 1996, 9) as well as changes of orders at short notice and response times to customer inquiries should be as short as possible.

All orders received by logistics services must be acknowledged, providing information on available stocks and expected delivery time.

Transaction elements are related directly to the physical distribution (Christopher, M. 1998, 40). Order size constraints may arise where larger but often significantly cheaper (hospital) packing is provided as a standard. However where large quantities are not suitable for providing assistance to small scale programmes, logistics services should be able to provide smaller packing sizes.

The expertise, willingness and ability to quickly offer a substitute for out-of-stock items, especially in emergencies, are important to avoid delays in providing assistance.

One key customer service element which must be measured and closely monitored is stock availability of items defined in programme standard lists. On the other hand offering a stock availability of thousands of health care goods like a commercial wholesaler, would exceed the resources humanitarian organizations have at their

disposal and not necessarily improve services provided to patients. Stock availability can be measured as line item fill rate per order or as order fill rate for entire orders (Simchi-Levi, D., Ph. Kaminsky, and E. Simchi-Levi 2003, 211). Stock availability can be measured at all tiers of the supply network. As stockouts upstream in the supply network do not necessarily cause a stockout for end-users (Lambert, R.S., and J.R. Stock 1993, 119), stock availability at the assisted health care facility has the greatest relevance.

The quality of labelling as well as the labelling in several languages is an important criterion for facilitating handling of consignments at customs and in recipient countries.

The offer of frequent deliveries must be balanced against the higher cost of not being able to consolidate shipments of consignments.

A second key customer service element is the total order cycle time and the percentage of on-time deliveries. However the later also depends on the ability of programme managers to plan ahead rather than placing urgent orders. The time span of the customer from placing an order until receiving the consignment, rather than only the time from receiving an order until shipment, must be measured (Lambert, R.S., and J.R. Stock 1993, 515).

The ability of humanitarian organizations to expedite urgently needed consignments is essential for managing emergencies as well as for avoiding stockouts or providing urgently requested replacement parts for health care equipment.

Service reliability and consistency are essential (Bowersox, D.J., and D.J. Closs 1996, 9) since they allow better planning than with on average faster but more unreliable order cycle times. Consequently logistics services should first seek to improve reliability of delivery before making an effort to reduce order cycle times.

Maintaining the high quality of purchased goods throughout the supply chain and avoiding damage during transport, storage and distribution is essential, especially for sensitive health care goods such as cold chain items or health care equipment.

The completeness and correctness of documentation, such as shipping documents or certificates of analysis, are essential for avoiding delays for customs clearance as well as for donor reporting and maintaining accurate stock records.

The measures of stock availability and delivery time can be combined into "on-time-in-full" deliveries (Christopher, M. 1998, 53). Completeness, on-time delivery, quality of documentation and the perfect condition of delivered goods make up the "perfect order" concept which is considered as the ultimate measure of quality in logistics operations (Christopher, M. 1998, 41).

The ability of logistics service to provide regular and accurate order status information, information on the location of goods as well as information about products, services and prices is also essential (Govil, M., and J.-M. Proth 2002, 86).

Finally the total logistics costs for filling orders is an important service element as any savings allow programme managers to increase the value of provided humanitarian assistance goods.

Post-transaction elements refer to services required after humanitarian organizations have distributed health care products.

Even if a humanitarian organization could continuously provide perfect services, perfection of logistics services would be unaffordable (Gudehus, T. 1999, 166). Consequently humanitarian organizations must make provisions for recovery in case of malfunction (Bowersox, D.J., and D.J. Closs 1996, 10) such as health care goods which do not conform to the required (quality) specifications, mispicking, incorrect

documentation or misled consignments. In these cases swift treatment of complaints and corrective action are essential.

Post-transaction services must also assist end-users in maintaining and maximizing the life time of health care equipment. Health care equipment should only be provided if after-sales services are ensured either by the manufacturer, humanitarian organizations or domestic health services. Since manufacturers or their representatives may be absent in the country or area receiving humanitarian assistance, logistics services of humanitarian organizations have to provide unavailable services and link commercial suppliers with the end-users.

Health care professionals need to be provided with comprehensive information and training on the use of health care equipment as well as on ensuring safety of patients and staff. Engineers and technicians must have access to all necessary information for installing, maintaining, servicing and repairing equipment as well as to detailed replacement part catalogues.

Logistics services of humanitarian organizations may have to substitute storage and ensure availability and rapid distribution of essential replacement parts. They must also recover malfunctioning, broken or damaged health care equipment and should provide temporary replacement products for essential equipment.

Finally health care equipment containing environmentally harmful substances may require return to the supplier for safe disposal.

4.5.3 Collaborative planning

Collaborative planning seeks to minimize end-user demand distortion (Gattorna, J. 1998, 200) by capturing real demand as near to the end-users and as soon as possible after end-user demand arises.

"In the absence of planning, managers must spend a disproportionate amount of their time in the role of “fire fighter” - reacting to crises rather than anticipating change and developing strategies to deal with it" (Lambert, R.S., and J.R. Stock 1993, 718). According to Thomas, A. logisticians are rarely included in the planning stages of humanitarian assistance programmes (Thomas, A. 2005, 60).

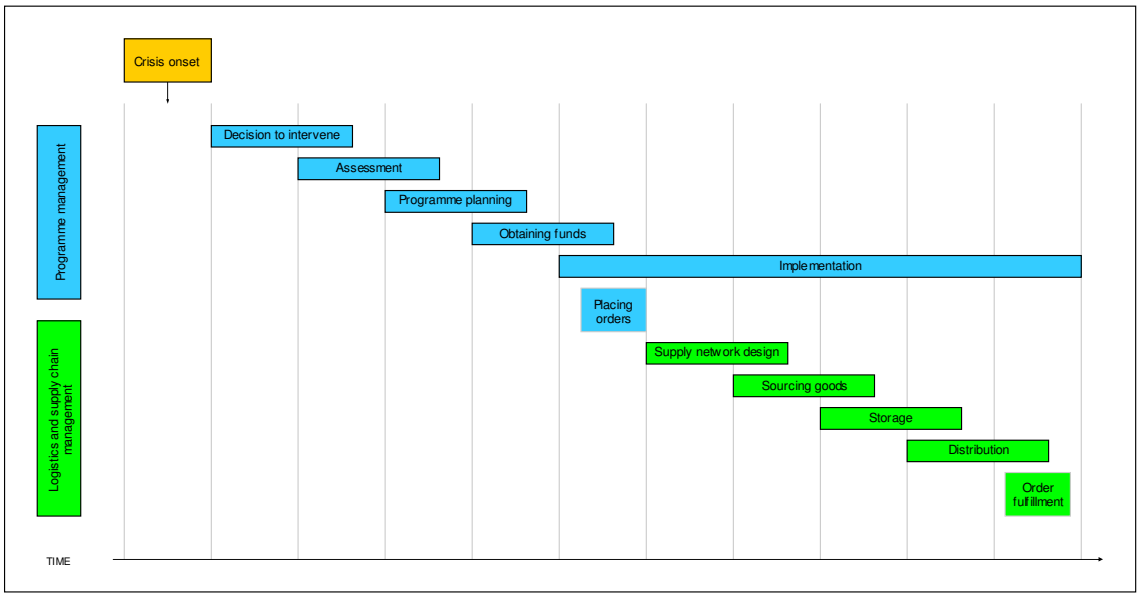

Figure 4.21 Subsequent planning process

Effective and efficient implementation of humanitarian assistance programmes requires close cooperation between health programme managers and logistics services (PAHO 2001, 146). Valuable time is lost if programme and logistics managers plan and carry out their activities after each other (figure 4.21).

Exact determination of specifications of health care products and establishing standard item catalogues allows narrowing down the number of items for which logistics managers have to anticipate demand considerably without compromising the quality of provided health care services.

Close collaboration is needed for offering immediately available substitutes rather than spending resources on sourcing health care goods which do not offer significant advantages over substitutes.

End-user demand arises as soon as a patient is injured or falls ill. In countries with chronic lack of adequate health services, needs may even persist for years before a specific humanitarian organizations decides to intervene, for example because health services have even declined further.

However a demand signal only arises once humanitarian organizations decide to provide assistance. Before developing assistance programmes, health professionals need to carry out assessments and obtain approval for assistance programmes as well as funds from donors. Consequently a considerable amount of time, weeks or even months, may pass between the decision of humanitarian organizations to intervene and placing of firm orders by programme managers. Collaborative planning allows to carry out activities in parallel (figure 4.22) and save valuable time.

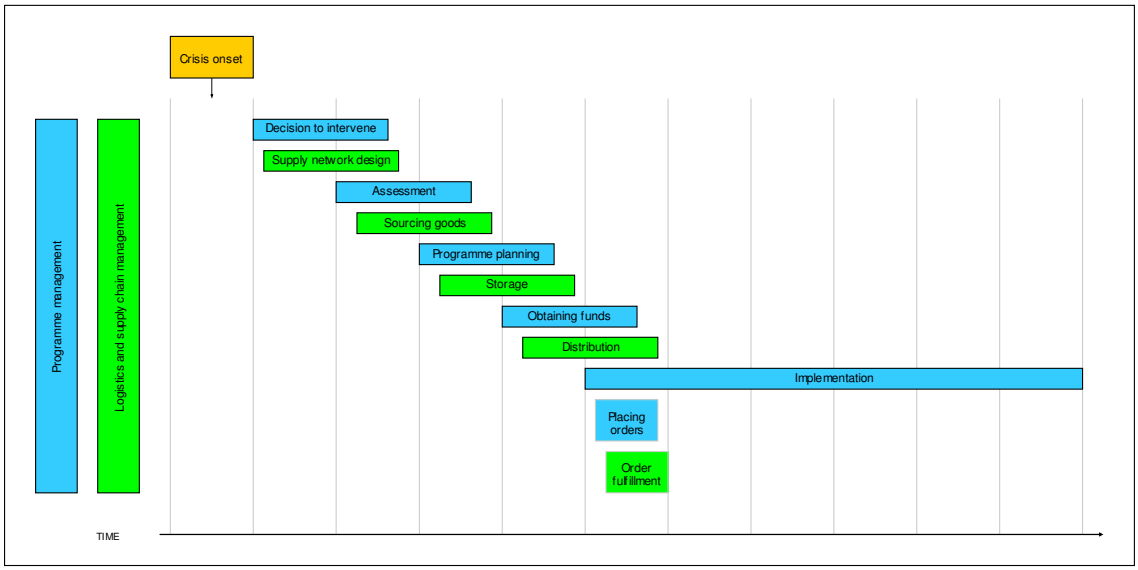

Figure 4.22 Parallel planning process

Demand can be anticipated by early warning systems and by health programme managers informing logistics services as soon as humanitarian organizations consider intervening (Thomas, A. 2004, 102). Likewise a continuous exchange of information allows logistics managers to quickly adapt their strategy and operations to any planned or actual changes in needs, humanitarian assistance programmes or treatment protocols.

Even before receiving firm orders, logistics managers can check (worldwide) stock levels of the most likely requested goods, inform suppliers of expected orders and draw up plans for expanding an existing or establishing a new supply network. Even if

health care goods are not purchased and distributed, lead times for these activities can be considerably reduced with advanced planning. Emergency stocks can be moved nearer or into the expected crisis area in anticipation of imminent demand from health programme managers. Logistics services must be considered as an enabler of humanitarian assistance programmes and become part in planning humanitarian assistance programmes rather than being limited to order fulfilment.

4.5.4 Customer service strategy

Logistics services of humanitarian organizations need to develop a general customer service policy but also need to tailor services to the context, constraints and requirements of individual humanitarian assistance programmes as well as to the needs of the respective end-users.

During the emergency phase of humanitarian assistance programmes the scope of services will be limited to providing essential services in order to use available resources to maximize the effectiveness of the response. For example during the emergency phase only pre-packed kits may be provided while at later stages the range of provided health care goods can be extended.

Providing the highest possible service level is essential during the emergency phase in order to avoid any delay of implementing humanitarian assistance programmes. Later the high costs of providing high service levels must be balanced against the benefits, minimizing total logistics costs for achieving a predetermined service level (Schulte, Ch. 1999, 9)

Logistics services can only be tailored to specific needs of humanitarian assistance programmes and to specific end-users once a certain routine for their supply has been established and individual needs are determined. For example, providing non-standard items, convenient packaging sizes, adjusting delivery schedules to the routines at health care facilities or servicing health care equipment.

During the immediate emergency phase information on the needs of health care is not available in detail yet and health programme managers will have to select the most suitable goods and quantities based on their experience and assessment of the situation. After a detailed assessment has been carried out, health professionals at assisted health care facilities will become the primary customers.

During the initial emergency phase immediate availability of logistics services, a single point of contact, high flexibility and high stock availability are essential to ensure an effective immediate response. Once reliable supply networks have been established, logistics managers must also ensure adequate post-transaction services such as returns or maintenance and repair of equipment. In an emergency humanitarian organizations may have no choice than to provide standard health care equipment, even at the risk that authorized dealers are unavailable domestically and equipment cannot be serviced or repaired in the country.

In a multi-echelon supply chain the intermediary storage facilities between the international distribution centre and the end-user can also be considered as customers. While logistics managers need to balance service levels and costs at upstream distribution centres, the highest possible service levels must be provided downstream and especially at assisted health care facilities.

Upstream logistics services will mainly serve internal customers such as intermediate distribution centres or programme managers, while the end-user becomes the only customer in the conflict area.

For highly critical health care goods and especially health care equipment, the scope of provided services must be large, such as customization of products, specialized packing, training, installation and maintenance.

Instead of providing the highest service level for the most profitable products (Christopher, M. 1998, 59), in humanitarian assistance the highest service levels must be provided for the most critical goods, especially for indispensable drug products and health care equipment.

Tailored services such as repair and maintenance, technical upgrades or regular training of technicians are justified for highly critical health care goods and logistics managers will therefore focus on ensuring adequate and sustainable post-transaction services.

The more critical health care goods are for the humanitarian assistance programme, the more programme managers will want to be involved in their selection.

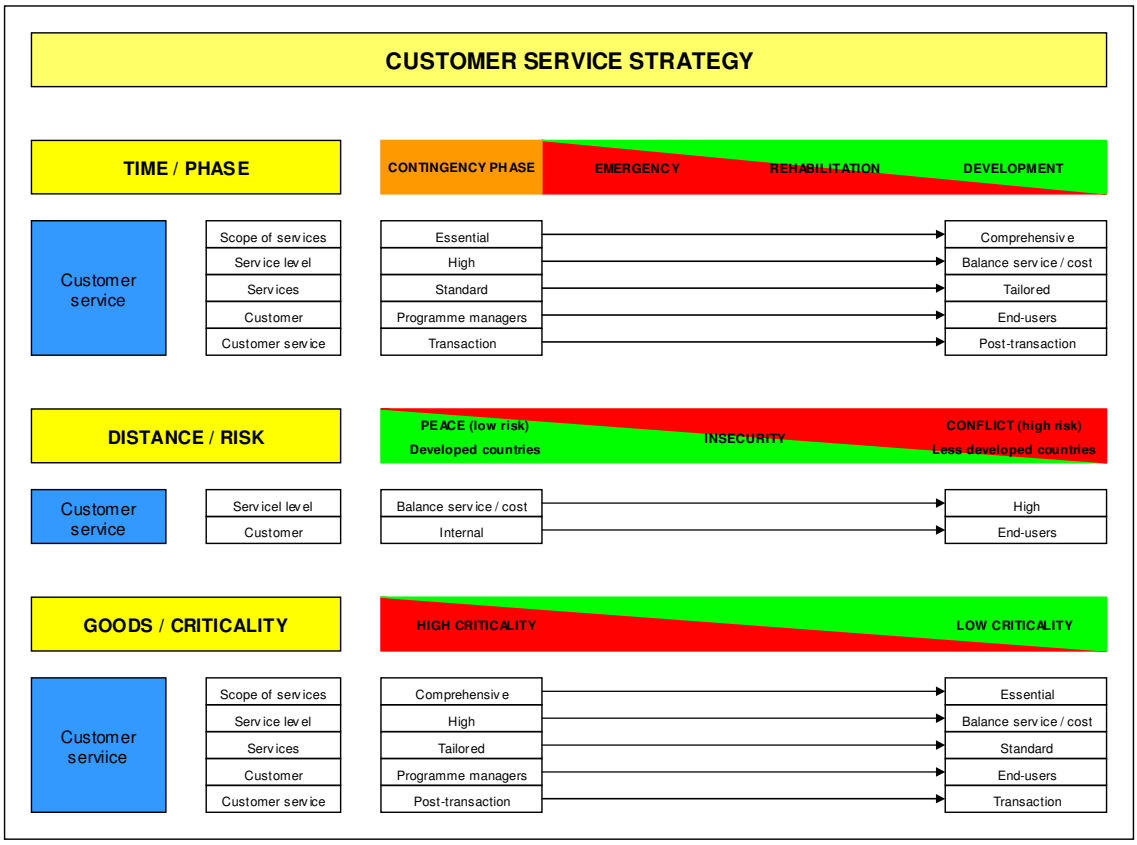

Figure 4.23 Customer service strategy

4.6 Communication and information management

The effective and efficient flow of goods and services depends on the accurate and timely flow of information across the entire supply chain (Harrison, A., and R. van Hoek 2002, 210) and effective information management is critical in emergencies (OCHA 2002, 23).

Health care goods available in a distribution centre are without value if the information on customer orders cannot be received and treated. Moreover effective and reliable communication is indispensable for ensuring the security and safety of

staff in the field. Likewise information management is vital especially during the emergency phase (Moody, F. 2001, 16).

Telecommunication is governed by national and international laws and closely related to national sovereignty of the host country (PAHO 2001, 163). The distinction between information such as conditions of transport infrastructure or presence of armed forces and military intelligence is fine (Mayhew, B. 2004, 23). Use of communication and information systems in conflict areas is highly sensitive as it may raise suspicion of gathering and communicating information which could benefit the adversary (Bickley, S. 2003, 75). Consequently importation and use of equipment is highly regulated and humanitarian organizations must obtain permission for importing as well as licences for operating equipment (Bickley, S. 2003, 88).

Establishing independent communication networks is a strategically important decision as it requires significant investment in telecommunication equipment, qualified staff for installing and maintaining networks as well as in training humanitarian workers.

Communication and information systems should be simple since non-specialist humanitarian workers need to be able to use them. Above all, communication and information systems need to be effective and reliable.

An important strategic decision is whether to rely on existing domestic infrastructure or to establish independent communication networks. The later are expensive to establish and maintain but avoid dependency on public networks which may be overloaded, disrupted, shut down by authorities or armed forces any time or may be damaged or destroyed in the course of armed conflicts.

4.6.1 Communication systems

Reliable communication, transmission of data, exchange of information, placing of orders and transmitting information on movement of goods is imperative for any humanitarian assistance programme (PAHO 2001, 163). The communication network must link means of transport such as vehicles, distribution centres (PAHO 2001, 123), authorities, suppliers, ports, customers as well as other humanitarian organizations. Telecommunication resources are essential for the security of humanitarian workers (UN General Assembly Resolution 58/122, 2004).

In areas where public communication infrastructure is not reliable, humanitarian organizations need to establish their own communication network (Ockwell, R. A. 1994, 425). Even where public communication networks are available, humanitarian organizations need to at least establish a rudimentary backup system in case the public network is disrupted (Bickley, S. 2003, 76). Especially during acute crises, telecommunication infrastructure is particularly prone to becoming overloaded, being damaged or simply purposely disabled by conflict parties (Mayhew, B. 2004, 31).

In particular complete dependency on mobile phone networks should be avoided (Mayhew, B. 2004, 31). Where humanitarian organizations are left to their own devices, they should establish a primary communication network (for example radio network) as well as a backup system (for example satellite communication) in case the first one fails (Mayhew, B. 2004, 31).

Where data communication infrastructure is unavailable, the ideal of real time exchange of data across the supply chain (Govil, M., and J.M. Proth 2002, 65) would be unaffordable with satellite communication systems and exceed available capacities with radio communication networks. Moreover the vulnerability to the disruption of communication networks increases with the sophistication of communication systems

(Lambert, R.S., and J.R. Stock 1993, 518). A compromise is to store information in mailboxes and regularly transmit consolidated information through the network. Humanitarian organizations need to decide what amount of resources they are willing to commit and what frequency of data exchange they want to achieve.

Where national and international telephone and data transmission networks are unavailable or unreliable, apart from using mail, humanitarian organizations can resort to establishing their own high frequency (HF) and very high frequency (VHF) radio networks (Mayhew, B. 2004, 97) for telex, teleprinter over radio (TOR) or packet radio. Installing satellite communication systems allow transmission of voice, fax as well as transmission of electronic data and use of electronic mail. These systems can be installed and dismantled quickly and also used as mobile devices for vehicles or ships. Despite the availability and ease of using satellite communication, the high cost favours the use of high frequency radio telecommunication for worldwide voice, email, text and data transmission (Klenk, J.S. 1997, 47).

The Internet is not considered as a reliable option in emergency situations as it depends on public telecommunication networks and is vulnerable to the disruption of switch stations and satellite links (Klenk, J.S. 1997, 49).

4.6.2 Information systems

Management in general and managing the flow of goods in a supply network in particular requires collecting, processing and transmitting large amounts of data. According to Long information systems are the most important factor for logistics services in humanitarian assistance in the context of emergencies (Long, D. 1997, 27). The easier information can flow across the supply network, the more responsive logistics services can be to changing demand (Gattorna, J. 1998, 277).

Humanitarian organizations first need to decide whether or rather where and to what degree to use manual records rather than electronic data storage and processing. Manual records do not allow data processing and electronic transmission but are reliable and do not depend on sophisticated equipment or reliable power supplies. Moreover computer systems are useless without competent staff to run them (Quick, J.D. (ed.) 1997, 741).

Where computer systems are used, a strategic decision needs to be made concerning the sophistication and complexity of hardware as well as software. Even running a simple server requires a trained technician for installation and maintenance. Electronic equipment is prone to theft as well as to damage by high humidity, dust as well as power fluctuations.

If computer systems are used the level and means of integration arises, using stand alone workstations or connecting them to networks. Permanently connecting computer systems worldwide would be prohibitively expensive. However work stations can be integrated into a network at a particular site and connected to other sites through periodic transmission of data packages.

Humanitarian organizations also need to decide whether to use simple software applications such as spreadsheets or use logistics applications for purchasing, order management, inventory control, warehouse management, vehicle fleet management or distribution management. Commercial logistics applications are expensive, complex and depend on reliable computer systems as well as efficient data transmission and are poorly adapted to the context of humanitarian assistance. Alternatively humanitarian organizations which can afford the investment can develop their own software or customize available commercial products.

A further strategic decision is whether to develop and implement worldwide tracking systems (Harrison, A., and R. van Hoek 2002, 247) for consignments or instead to use a (parcel) carrier who offers this service.

Whether manual or electronic information systems are used, humanitarian organizations must ensure that each batch of health care goods can be traced worldwide in order to allow immediate retrieval of stocks at distribution centres or customers in case a quality defect requires a batch recall.

Various software applications have been developed to suit the needs of humanitarian organizations. However these concentrate on tracking donated goods from their arrival until their final distribution in order to provide accurate donor reports and do not provide features for inventory control and stock replenishment. For example the Pan American Health Organization (PAHO) has developed the Humanitarian Supply Management System (SUMA) which allows registering, identifying, sorting and classifying donations, prioritizes distributions according to known needs and allows preparation of detailed reports during disasters (Tomasini, R.M., and L.N. Van Wassenhove 2004, 440).

4.6.3 Communication and information management strategy

Immediate availability or the rapid establishment of communication and information systems throughout the supply network is essential and must be the priority during the initial emergency phase.

In order to ensure that communication systems are reliable, humanitarian organizations must establish and maintain their own networks during the emergency phase. Public networks can be used as soon as they are restored and reliable while at least a rudimentary backup system with own means should be maintained.

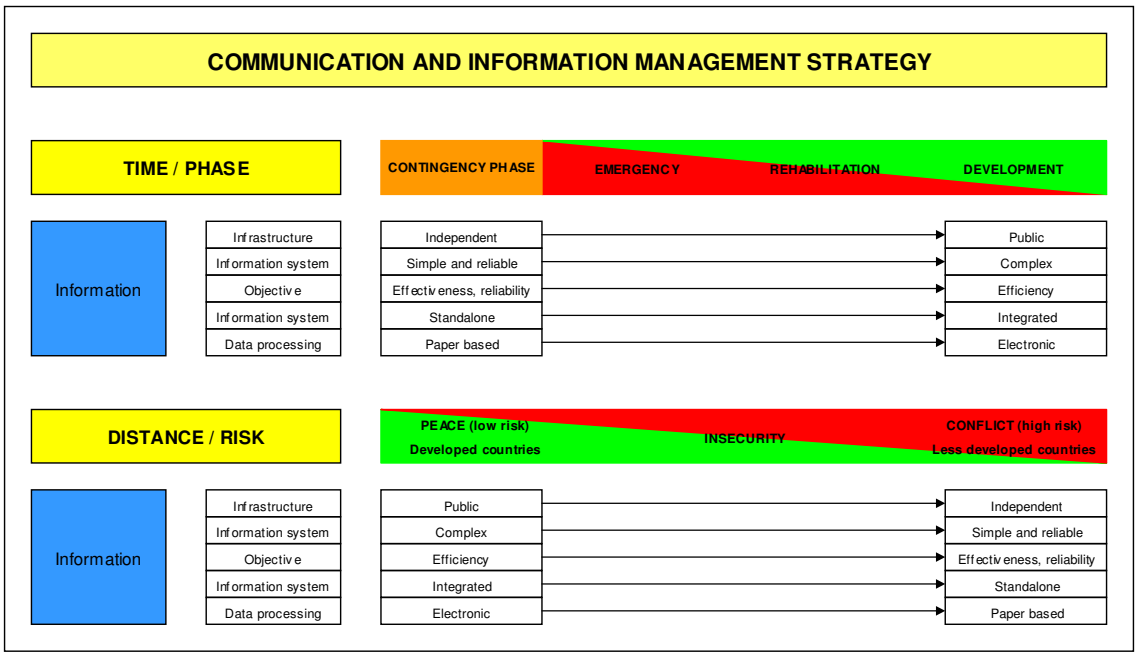

Figure 4.24 Communication and information management strategy

Information systems must be simple during the emergency in order to be operational immediately. Manual records can be used without being dependent on reliable power supplies and sophisticated computer equipment and manual records should be

maintained in any case as a backup system. If computers are used, simple standalone systems with software which does not require maintenance by a qualified technician should be preferred. When reliable support services can be provided to humanitarian workers, more complex and sophisticated information systems with greater functions can be implemented.

During the initial emergency phase the main objective is to quickly establish effective and reliable communication systems, such as satellite communications, even if their cost is high.

While humanitarian organizations can rely on more cost-efficient commercial and public communication systems in less developed countries as well as outside the crisis, independent and reliable communication systems are needed near and inside the crisis area. Here reliability and effectiveness are more important than providing complex functions.

In order to ensure reliability, sustainability and consistency, information systems of low complexity and sophistication should be used inside the crisis area. Outside however, more complex information systems can be used or established which allow providing additional services and improving efficiency of supply chain management. For the same reasons, communication systems outside the crisis area can be integrated, linking different sites and services of humanitarian organizations.

5 SUPPLY CHAIN PLANNING

The following chapter will explore the tactical aspects of each of the logistics processes presented in table 3.8 by considering the context and constraints of humanitarian organizations as well as the logistics and supply chain management objectives developed earlier.

5.1 Item selection

The standard item catalogue significantly reduces the number of health care goods which logistics services need to handle. Nevertheless managing several thousand different health care goods in the context in which humanitarian organizations work would require complex operations and large resources. Consequently programme managers need to narrow down the standard item catalogue further and select a few hundred essential health care goods which cover basic needs and are most suitable for the context and programmes in a specific country.

Reducing the number of (regularly) distributed health care goods facilitates quality assurance and reduces the overall complexity of logistics and supply chain management (PAHO 1983, 20). Effectiveness, reliability and consistency are increased as a smaller number of health care goods reduces demand variability and makes it easier to provide higher service levels. The smaller number of goods which need to be managed throughout the supply network increases efficiency and facilitates tracking of distributions and accurate donor reporting. Providing a limited number of essential health care goods also ensures that the most urgent health needs are covered first (PAHO 1983, 49). For example 5-15 different drug products should suffice for a health post, 20-40 drug products for a health centre (Dörner, G. (ed.) 1992, 7) and 120 for a district hospital (Tigretti-Berthoud, Th. 1998, V).

Health programme managers must also decide whether to order and distribute individual health care goods or supply health care facilities with pre-packed kits.

5.1.1 Programme standard list

The essential drugs concept as well as the principle of establishing standard lists of drug products and equipment according to the prevailing epidemiological situation is part of the Primary Health Care concept (WHO 1978, 66). It applies to national health systems as well as to humanitarian organizations (Health Action International, 1998). Moreover, without standardization, the list of requested health care goods tends to be long (Quick, J.D. (ed.) 1997, 152).

For establishing a programme standard list the effectiveness and efficiency of managing a small number of health care goods (WHO 1988, 6) must be balanced against the quality and level of health care services which can be provided with a larger number of items. Consequently programme standard lists need to be developed systematically and adapted to changes of programmes. However frequent and extensive changes should be avoided since they make reliable supply chain management more difficult and may require additional training of health staff (WHO 1998a, 26 ff.).

Developing programme standard lists also ensures coherence and consistency when assisting several health care facilities of the same type and avoids changes of health care goods based merely on personal preferences.

The selection of health care goods first depends on the most prevalent (Quick, J.D. (ed.) 1997, 122) and most commonly treated medical conditions in the respective country, in health care programmes as well as assisted health care facilities, on the level of health care the humanitarian organizations wants to provide (Dörner, G. (ed.) 1992, 9) as well as on the competence of health staff (WHO 1998a, 4). Standard treatment protocols (Quick, J.D. (ed.) 1997, 122) developed by national authorities, international organizations such as the World Health Organization or by humanitarian organizations also determine necessary health care goods.

National health policies and national essential drug lists (WHO 1998a, 2) also provide a framework for selection of the most suitable health care goods and ensure that health professionals are familiar with provided health care goods (PAHO 2001, 149). Finally inventory lists from assisted health care facilities can be consulted as a further reference.

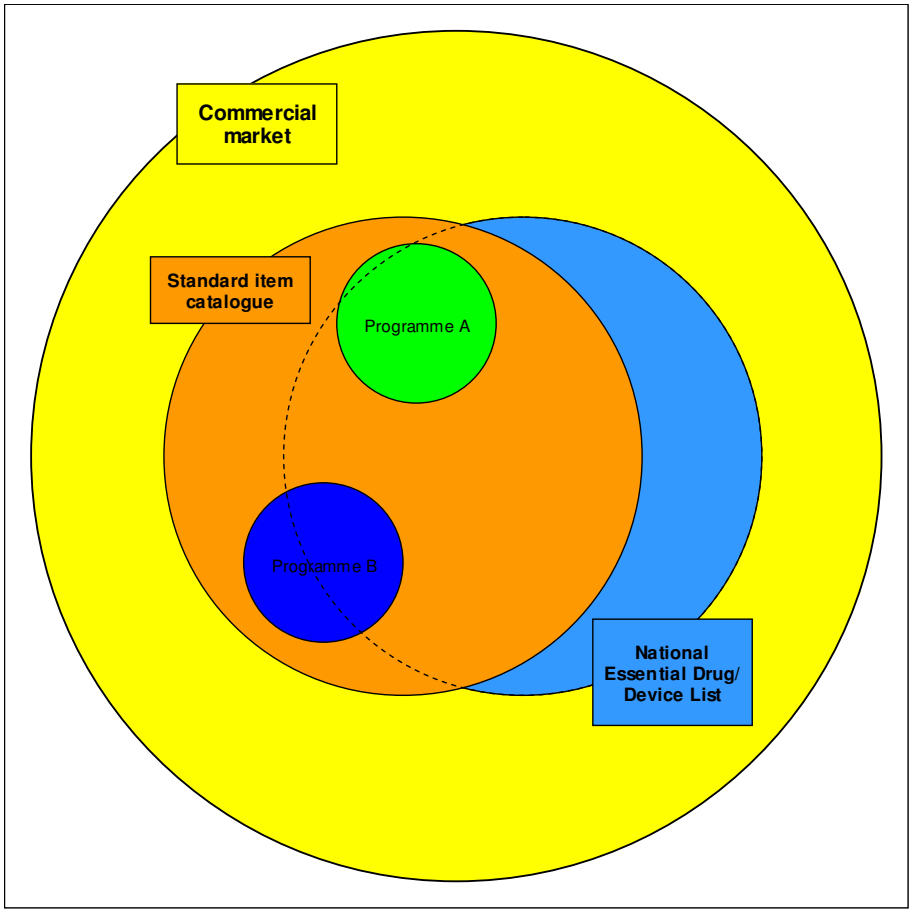

Figure 5.1 Development of programme standard lists

All health care goods should be approved for use in the recipient country and health professionals should be familiar with presentation, strength and formulation (PAHO 2001, 149). Depending on the development of national drug legislation, the importation of drug products requires a notification, authorization or full registration procedure by the national drug regulatory authorities (WHO 1988, 51).

In a similar way model lists for essential medical devices and equipment (WHO 2003, 18) can be developed for countries or individual health care facilities. Determining appropriate health care interventions for the prevalent medical conditions

as well as the appropriate level of technology allow selecting equipment which is necessary to provide the required medical care (Temple-Bird, C. 2005, 77).

As far as possible, health professionals should already be familiar with health care equipment and maintenance and repair services should be available domestically.

5.1.2 Kits versus separate items

If humanitarian organizations have taken the strategic decision to include kits in their standard item catalogue, their suitability, advantages and disadvantages (figure 5.2) have to be considered for each country and each heath care programme where humanitarian organizations provide assistance.

Kits are used for emergency preparedness and emergency response planning when the needs have not been assessed yet (Quick, J.D. (ed.) 1997, 408) and the destination of kits is not known yet as well as in acute emergencies (WHO 1999a, 11). Kits may also be used as a simple and cost-efficient long-term distribution strategy (Quick, J.D. (ed.) 1997, 408).

Kits should also be used where logistical capacities, such as medical stores and information systems, as well as skills are not (yet) sufficient to handle a large number of separate items.

Kits are also useful for supplying specific programmes such as vaccination campaigns or management of a cholera epidemic.

The use of kits has several advantages for assisted health care facilities and improves the quality of care. As the contents of kits are designed by specialists and are based on extensive field experience, all contained goods are essential, suitable for the context of humanitarian assistance and the contents covers all essential needs. Kits allow a swift response with health care goods which allow addressing the main health needs (WHO 2006a, 3).

Health staff which lacks the experience and knowledge for selecting individual items and determining quantities can provide appropriate assistance simply by selecting the correct kit. As kits are designed for a specific purpose and a defined number of treatment episodes (Quick, J.D. (ed.) 1997, 408) or for the needs of a certain population, health programme managers only need to determine the kind of need and the number of customers which require assistance rather than forecasting demand for separate items. For example the Interagency Emergency Health Kit is designed to provide primary health care services to a population of 10,000 people during three months (WHO 2006a, 4). For the same reason budgeting of humanitarian assistance programmes is far easier with kits than with separate items.

Humanitarian assistance can easily be adapted to the level of skills of health professionals by selecting kits with the appropriate contents and variety of goods. For example the Interagency Emergency Health Kit is intended for use by basic health workers and therefore does not contain any injectable drug products (WHO 2006a, 4). The contents can be designed according to standard treatment protocols (Hanquet, G. (ed.) 1997, 136) and providing essential drugs encourages rational prescription and drug use.

The possibility to handle a large number of separate items as a single item (Quick, J.D. (ed.) 1997, 416) and therefore reduce complexity, has many advantages for logistics and supply chain management and greatly increases the effectiveness and efficiency of humanitarian assistance.

Kits can be handled by inexperienced logistics staff with a low level of professional skills. The small number of different items which need to be handled throughout the supply network greatly facilitates information management, record keeping and documentation as well as tracking of distributions and donor reporting.

Forecasting a small number of items is easy and can be done manually if electronic information systems are not yet available. The aggregation of goods increases forecasting accuracy (Simchi-Levi, D., Ph. Kaminsky, and E. Simchi-Levi 2003, 49) and therefore allows reducing safety stock levels (Quick, J.D. (ed.) 1997, 413).

The ease and efficiency of purchasing is increased with kits and they can be managed in a simple store without the need for special storage equipment. As several items are densely packed in a kit and do not need to be stored separately, the required storage space is greatly reduced. Multiple put-away, order picking and packing of separate items along the supply network becomes unnecessary.

The known weight and volume of kits facilitates planning of transport requirements and capacities. Logisticians can keep track of a few different kinds of kits much more easily than for a large number of separate items and visibility of stocks along the supply chain is enhanced.

The use of kits reduces pilfering and generally improves availability of health care goods at assisted health care facilities (Quick, J.D. (ed.) 1997, 413).

The numerous advantages have to be balanced against some disadvantages. Providing kits instead of separate items reduces flexibility in tailoring humanitarian assistance programmes to the region, climate, prevailing medical conditions, to different health care programmes and different health care facilities (Quick, J.D. (ed.) 1997, 410).

The contents may not be adapted to the national treatment protocols, the training health professionals have received and their practices. Therefore health professional need to familiarize themselves with the contents quickly and may even require some training.

As the contents of kits is pre-determined there is a danger that some health care goods are unnecessary for a specific context (Quick, J.D. (ed.) 1997, 409), will not be used at the assisted health care facility and might be wasted. When provided quantities of health care goods exceed demand, a surplus accumulates which will be wasted if it is not re-distributed to other health care facilities. The ratio of health care items may be unsuitable for the context. Consequently increasing the number of distributed kits in order to avoid shortages of items with the highest turnover will lead to accumulation of other goods with a lower turnover.

Health professionals may be tempted to prescribe or administer drug products which are available rather than selecting the most suitable drug product.

Since kits are not routinely used by health care facilities in either developed or less developed countries, the number of suppliers offering medical kits is limited (Quick, J.D. (ed.) 1997, 411) and sourcing may be difficult. Especially in emergencies where a large number of humanitarian organizations want to purchase from the same few suppliers. If suppliers do not keep kits in stock, lead times will be long.

Health care goods with the largest demand will stock out while others will accumulate and eventually expire before used. The use of inventory control systems may be interrupted and staff may lose their skills (Quick, J.D. (ed.) 1997, 410). Seasonal changes in demand cannot be accommodated and health care goods, especially drug products, with higher seasonal demand will quickly stock out.

Since health care goods with different expiry dates and therefore different remaining shelf lives are combined, the item with the shortest remaining shelf life dictates management of the entire kit. Consequently entire kits may have to be distributed quickly although the majority of their contents still have long remaining shelf lives.

Advantages of kits	Disadvantages of kits
• Ensures that all goods are essential • Usefulness of contents proven for its purpose • Designed to cover essential needs • Ensures completeness • Improves quality of care • Facilitates selection (by inexperienced staff) • Easy to adapt to level of skills • Universality of use • Promotes rational prescription and drug use • Facilitates budgeting of programmes • Facilitates ordering • Allows handling by less skilled staff • Increases effectiveness of supply chain management • Reduces complexity • Smaller number of items to manage • Facilitates record keeping and documentation • Facilitates information management • Facilitates donor reporting • Facilitates forecasting and inventory control • Lower safety stock level need (aggregation) • Facilitates purchasing • Reduces picking and packing time • Can be managed with simple storage equipment • No need for put-away, picking and packing • Requires less storage space • Facilitates emergency stock management • Facilitates stock visibility along the supply chain and among humanitarian organizations • Facilitates tracking of goods • Known weight, volume and value • Facilitates distribution • Easy to transport • Reduces pilfering • Improves availability of health care goods • Allows immediate response to emergencies	• Ensures that all goods are essential • Reduces flexibility • Regional differences of needs not considered • Differences of health care programmes not considered • Not adapted to staff training and practices • Need for familiarization • Requires training of staff • Possible wastage of surplus goods • Possibly unsuitable ratio of items • Shortage or lack of certain items • Prescriptions based on supply • Smaller number of suppliers • Long supplier lead times • Stockout of goods with highest demand • Can disrupt existing inventory control systems • Loss of inventory control skills • Seasonal changes cannot be considered • Combines goods with different expiry dates • Difficulty in monitoring expiry dates

Figure 5.2 Advantages and disadvantages of kits

During the transition from using only kits to using individual items, a small number of individual items with high demand can be added to standardized kits to overcome the lack of flexibility.

As transition but also to simplify long-term assistance to health care facilities, kits can be customized for a specific programme or area. Health programme managers only need to determine the frequency of delivery and quantity of these pre-packed kits for each health care facility.

Once the supply network has been established and a thorough assessment of the needs of health care facilities has been carried out, individual goods can be provided to health care facilities to meet their individual needs (WHO 2006a, 7).

5.2 Sourcing

Within the strategic sourcing framework of humanitarian organizations tactical decisions on the tender format, supplier selection and the type of purchasing contracts need to be taken.

The primary concern is ensuring the reliable supply of high quality health care goods. Moreover commercial laws and regulations in the country of purchase must be adhered to. Another important consideration is the need for transparency as well as accountability towards donors. The selection of suppliers must ensure purchasing the best possible overall value for the resources provided by donors and the entire purchasing process must be transparent and well documented to allow later auditing by donors.

5.2.1 Purchasing method

The choice between open and restricted tenders is one of the most important decisions in purchasing (Quick, J.D. (ed.) 1997, 234) and must consider national legislation as well as donor requirements.

In open tenders all interested suppliers can participate (Quick, J.D. (ed.) 1997, 234) and submit their bids. Unsuitable suppliers are eliminated through post-qualification which reviews their registration status and qualifications as well as the quality of their products and, where applicable, past performance (Kaur, M. et al. 2005, 179).

Compared to restricted tenders, open tenders increase the number of potential suppliers and offered health care products and therefore increase the competitiveness among suppliers which is likely to result in lower prices. However since no preconditions are set, the participation of unreliable suppliers as well as the risk of receiving bids for poor quality health care goods increases.

The main disadvantages of open tenders are the potentially large number of suppliers and samples of health care products which have to be assessed. Since the quality of health care goods, especially drug products, is difficult to asses only by evaluating a sample, the qualification should include visits of manufacturing facilities, which are time-consuming and require specialists. Consequently open tenders should be limited to health care products which do not require visiting and validating suppliers and where significant savings can be expected by the competition among suppliers.

While in principle any supplier can participate in the pre-qualification process, only those who have been evaluated, approved and registered can participate in restricted (closed) tenders (Kaur, M. et al. 2005, 114). Since pre-qualified suppliers have been carefully audited, humanitarian organizations can be sure that all their products fulfill the quality requirements (Kaur, M. et al. 2005, 114). A thorough pre-qualification procedure ensures that all participating suppliers comply with the required quality standards and avoids that substandard health care goods are purchased (Quick, J.D. (ed.) 1997, 234). The smaller number of participating suppliers reduces the resources required for purchasing and increases the transparency of the purchasing process. Moreover the tender process can be completed faster (Kaur, M. et al. 2005, 100).

While pre- as well as post-qualification both require considerable time, pre-qualification procedures can be completed before a tender is issued and lead times for purchasing are reduced. Moreover pre-qualification of suppliers is recommended by the World Health Organization (WHO 1999d, 10) and will therefore be the method of choice for humanitarian organizations.

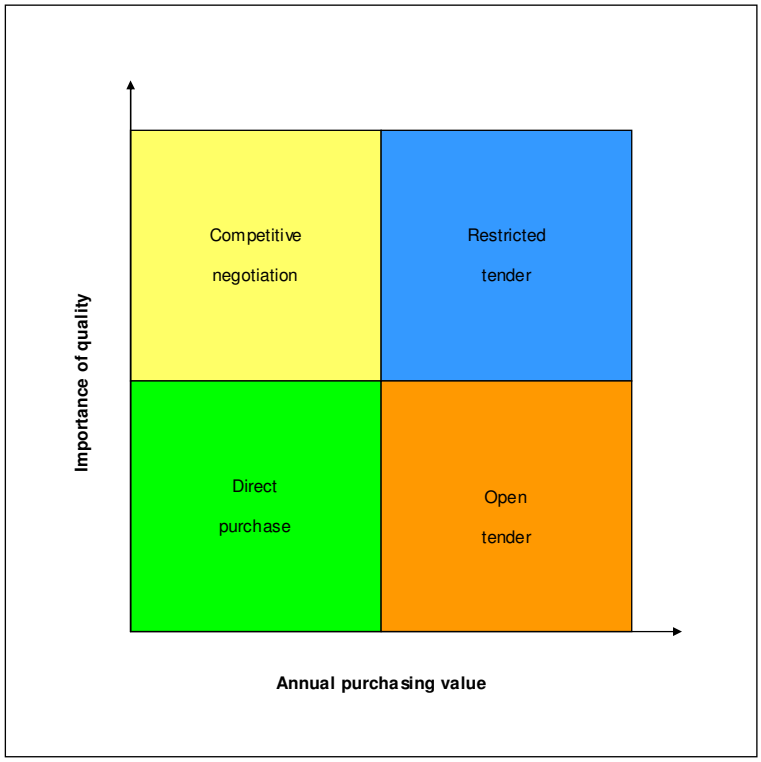

Figure 5.3 Framework for selecting purchasing methods

Where the resources for completing an entire tender process are not warranted because of the low value of health care goods or because of lack of time but quality of health care goods is important, a small number of known potential suppliers can be approached with competitive negotiation (Kaur, M. et al. 2005, 94).

Direct purchasing usually results in higher prices but is the fasted method and is preferred in emergencies (Kaur, M. et al. 2005, 94) provided that the importance of quality for the required health care goods is not high. Despite the lack of transparency, donors will usually accept direct purchasing only for purchases of low value and up to a clearly defined limit (ECHO 2003, 13).

The framework presented in figure 5.3 proposes criteria for selecting appropriate tender formats. For health care goods with high annual purchasing values donors will insist on following a detailed tender process in order to ensure that the best possible use is made of donated funds. For goods which must comply with high quality standards, restricted tenders should be used in order to limit the resources required for validating suppliers while health care goods with lower quality requirements can be purchased through open tenders since no resources are needed for supplier visits.

Allocating significant financial and human resources is not economical for one-off purchases and purchasing low value items (Kaur, M. et al. 2005, 179). Health care goods with low annual purchasing value which must be of high quality can be purchased from known suppliers through competitive negotiations. Direct purchasing increases the risk of purchasing low quality goods, has the least transparency, carries

the greatest risk of favouring suppliers and must therefore be restricted to health care goods with low annual purchasing value.

5.2.2 Supplier selection

From the bids submitted by qualified suppliers, humanitarian organizations need to select the most suitable suppliers and products according to defined criteria such as quality, price, service and reliability (Schulte 1999, 221).

Health care goods must generally comply with the requirements laid down by humanitarian organizations in their standard item catalogue and the criteria discussed in chapter 4.1.1. An important criterion is the remaining shelf life upon delivery and for drug products suppliers must provide Certificates of Analysis (WHO 2002a, 4) for each batch.

Suppliers should be easily accessibly, available during holidays in case of emergencies and flexible in responding to special requests and changes at short notice. Ordering should be convenient and suppliers should respond quickly to any inquiries. Availability of a worldwide network of authorized distributors allows reducing transport costs as well as order cycle times for assisted health care facilities.

Suppliers must be able to provide detailed information on their products, documentation on their manufacturing process, operating and service manuals for health care equipment as well as accurate shipping documents.

Especially for highly critical items, one of the key criteria is stock availability (Chopra, S., and P. Meindl 2004, 406) and the ability and willingness to provide suitable substitutes in case of stockouts. The absolute order cycle time, variability of lead times as well as on-time performance are important criteria which determine the safety stock levels humanitarian organizations need to maintain as well as the quality of services they can provide to their customers. Suppliers should also have the capacity to deliver and expedite shipments in case of emergencies.

Other service criteria are the ability to provide special packing such as for dangerous goods, the capacity to delivery directly to assisted health care facilities or at least national distribution centres worldwide as well as to maintain accurate documentation on shipments which allows to trace individual batches and products in case of their recall.

The purchasing price of health care goods, which comply with required quality standards, is only part of the costs incurred by humanitarian organizations and acquisition, ownership and post-ownership costs need to be considered. The total cost of ownership (Schary, Ph.B., and T. Skjøtt-Larsen 2001, 204) considers additional costs for supplier selection, quality management, inventory management, supplier management, inbound transportation, communication with suppliers as well as final disposal of goods. For health care equipment the cost of installation, testing, training, operations, maintenance, servicing, repairs and savings from costs covered by warranties as well as downtime and expected life time of equipment must also be considered. The purchasing price accounts only for an estimated 20% of the overall cost of ownership of health care equipment (Kaur, M. et al. 2005, 50).

For health care equipment worldwide availability, quality, reliability and cost of after-sales services are important selection criteria (Kaur, M. et al. 2005, 59). Since health care equipment must be sustained for many years after being purchased, availability of a worldwide network of qualified technicians who can install, calibrate, test, service and repair equipment as well as train staff at assisted health care facilities are key criteria for supplier selection.

Operating materials such as lubricants or calibration solutions as well as service and replacement parts should be available in the country receiving humanitarian assistance since otherwise health care facilities will stay dependent on humanitarian organizations for operating equipment.

The coverage and conditions as well as length of warranties are an important factor for the overall costs as well as for the costs which will be incurred by health care facilities after equipment is handed over to them.

The speed of responding to claims, complaints and handling returns as well as final disposal of equipment by suppliers are also important criteria.

Among several suppliers offering products which comply with the minimum quality and service requirements, humanitarian organizations must consider the trade-off between quality, service and price (ECHO 2003, Annex V, 2).

5.2.3 Purchasing contracts

Humanitarian organizations need to take unpredictability of demand as well as the required resources into account when considering purchasing contracts.

Volume contracts allow combining the purchasing requirements over a certain period of time, for example one year, and negotiating lower purchasing prices (Lambert, R.S., and J.R. Stock 1993, 506). In order to reduce annual storage costs of the buyer, partial (scheduled) deliveries over the period of the contract can be agreed on. Since the purchasing volume is determined in the contract, purchasers carry the risk of overstocking or shortages (Quick, J.D. (ed.) 1997, 235).

With system contracts (Lambert, R.S., and J.R. Stock 1993, 507) the purchasing price is negotiated for a certain volume over a specified time period but the supplier makes partial deliveries of the quantities and at the time requested by the purchaser. This allows humanitarian organizations to negotiate overall lower purchasing prices and to reduce purchasing costs but replenish stocks according to varying demand of their customers. Stock levels can be minimized or even eliminated with stockless purchasing, where the required quantities are called off from the supplier as needed.

The greatest flexibility for the purchaser is achieved by negotiating a fixed purchasing price but without determining the purchasing quantity over the period of the contract (Quick, J.D. (ed.) 1997, 235). The contract is based on an estimate of the expected annual purchasing quantity without a commitment of the humanitarian organization to purchase a specific quantity. Suppliers carry the risk of selling at a low price even if the annual purchase value is lower than estimated but have the advantage of being the only supplier during the entire contract period. Purchasers can order any quantity at any time at a fixed price, do not risk overstocking if demand decreases and can quickly react to sudden increases in demand. Regular ordering of smaller quantities reduces average stock levels and therefore increases remaining shelf life of goods.

Humanitarian organizations can also negotiate consignment stocks which are stocked at the warehouse of the buyer but remain the property of the supplier (Steinbuch, P.A. 2001, 237). The buyer has the right to withdraw any quantity at any time and only pays the supplier for the quantities which are shipped to customers. Stocks are available to humanitarian organizations any time and immediately without the risk of overstocking and without the need to purchase goods they hold in stock (Schulte, Ch. 1999, 180).

Because humanitarian organizations need to provide a fairly large number of health care goods with often highly uncertain demand, system contracts with estimated purchasing volumes are the most favourable purchasing contract.

5.3 Inventory control

After the location of storage facilities has been determined, humanitarian organizations need to consider suitable methods for demand forecasting as well as an inventory control policy for each storage facility. Finally criteria for deciding at which tiers of the supply network individual items will be stocked need to be developed.

5.3.1 Demand forecasting

Even though it is desirable to establish flexible and responsive supply networks and substitute responsiveness for inventory (Christopher, M. 1998, 54), order cycle times can only be reduced but not completely eliminated and future demand must be forecasted at all tiers of the supply network.

Demand forecasts can be made at several different levels, representing a forecasting hierarchy (DeLurgio, St.A. 1998, 11) with different degrees of demand aggregation at each level (figure 5.4). Unlike commercial companies, overall demand for humanitarian assistance always by far exceeds supply (Stockton, N. 2001, 11). Consequently humanitarian organizations are always able to utilize funds they receive and do not have to be concerned about developing excess capacities.

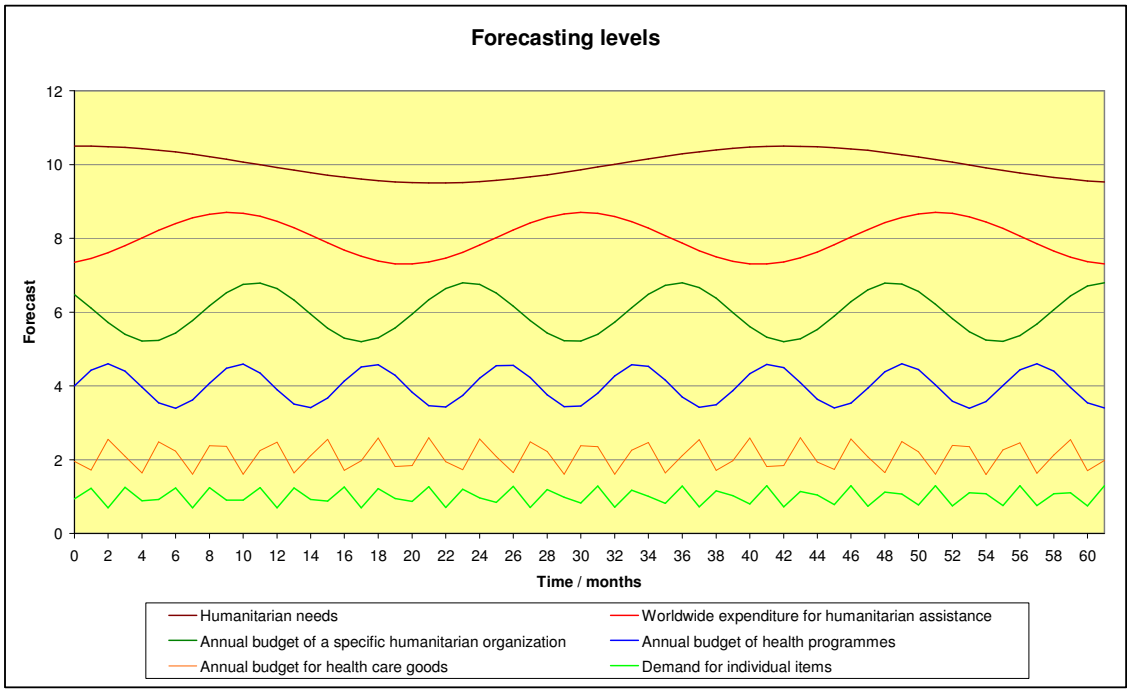

Figure 5.4 Forecasting hierarchy

At the macro level (Silver, E.A., D.F. Pyke, and R. Peterson 1998, 11) the overall worldwide need for humanitarian assistance depends, among others, on the world's population, poverty levels as well as the number, extent and intensity of conflicts.

Regardless of the overall need for humanitarian assistance, worldwide expenditure for humanitarian assistance is limited and every humanitarian organization is limited by

its own budget. Like commercial organizations, humanitarian organizations must establish annual budgets which can serve as an orientation for the overall number and size of humanitarian assistance programmes which can be expected. Although donor funding will often increase with acute crises, many humanitarian organizations are competing for the same funds and the extent to which a humanitarian organization can quickly expand its capacity is limited.

Depending on their field of expertise, humanitarian organizations will devote a certain proportion of their overall budget to health care programmes and reserve a certain amount for purchasing health care goods. Although the annual value of purchased health care goods will vary to some degree, expenditures of the past year allow forecasting an upper limit for the future.

At the next lower level total expenditure for health care goods can be forecasted by country and by project, at least for humanitarian assistance programmes which are ongoing at the time of forecasting. Forecasts at this level are particularly important for planning needs and capacities for logistics resources such as staff, distribution centres or means of transport.

At the micro level demand for health care goods can be forecasted by group of goods such as drug products or health care equipment and finally at the item level for a whole country, whole health care programmes as well as individual assisted health care facilities.

In order to plan and allocate resources, logistics managers must also forecast geographical markets for humanitarian assistance. Health programme managers need to consider likely developments and possible expansions of complex political emergencies, the size of affected populations as well as likely health care needs in geographical regions as well as individual countries.

Provided that no large scale displacement of populations occur and that people throughout a country or region are affected equally, needs for humanitarian assistance will be proportional to population densities.

The size of a population a humanitarian organization has decided to serve allows estimating the number of required health care facilities which in turn allows estimating needs for health care goods. For example a dispensary or local clinic can serve a population of 5,000 - 10,000 and a district hospital 100,000 - 200,000 people in peace times (Perrin, P. 1996, 219). Experience allows estimating that approximately one percent of a refugee population will consult a dispensary or clinic every day, approximately one percent of these will require hospitalization and one hospital bed should be calculated for every 1,000 persons (Perrin, P. 1996, 222).

Health care needs will be increased by the effects of complex political emergencies but demand on health care facilities may also decrease because of reduced accessibility for patients (Perrin, P. 1996, 319).

Demand should be forecasted only for essential and regularly used health care goods while non-essential goods which are not used regularly can be ordered when needs arise and can be delivered directly from the supplier. This distinction allows providing high service level for the majority of required health care goods, limiting the stock value and avoiding accumulation of health care goods with low turnover.

In order to ensure that all essential health care goods are available and no unnecessary goods are stocked, demand should be forecasted for all items which are included in the respective programme standard lists. Stock items are regularly replenished according to demand forecasts while all other items are ordered as and when requested from customers (Gudehus, T. 1999, 120). This corresponds to a push-

strategy and keeping stocks of items with low demand variability and a pull-strategy for items with high demand variability which are ordered directly from suppliers without the need for maintaining stocks and forecasting demand (Simchi-Levi, D., Ph. Kaminsky, and E. Simchi-Levi 2003, 122).

Generally demand for health care goods must be considered as independent and stochastic. Forecasts for future demand will rely on statistical analysis of historic demand data (Steinbuch, P.A. 2001, 57). Wherever possible, independent demand should be converted into dependent demand as the later no longer requires forecasting. Rationing systems distribute a fixed amount of health care goods at fixed intervals to a defined number of health care facilities. The total amount of kits can easily be calculated and forecasts are unnecessary. However either assisted health care facilities have other additional supply sources to cover increased demand or the number of provided rationing kits allows covering for possible increases in demand.

For replacement parts independent demand can be converted into nearly dependent demand by applying preventive maintenance (Lonergan, E. 2003, 65). Certain parts of health care equipment such as fuses, filters or tubing are replaced at regular intervals even if they are not damaged or worn rather than waiting until parts become defective and have to be replaced.

The use of kits itself does not create dependent demand. However since a large number of goods are combined in kits, the variability of demand for kits is greatly reduced through demand aggregation of individual goods (Simchi-Levi, D., Ph. Kaminsky, and E. Simchi-Levi 2003, 127).

In order to minimize demand distortion, demand data must be collected as far downstream in the supply network and as near to the end-user as possible (Schary, Ph.B., and T. Skjøtt-Larsen 2001, 324).

Ideally demand data would be recorded whenever health professionals or patients use or consume health care goods. However collecting demand data directly from end-users would require unreasonably large resources.

In many less developed countries wards do not keep stocks of health care goods but are supplied from the hospital pharmacy daily according to patient needs. Therefore the aggregate daily demand on the hospital pharmacy corresponds to the aggregate daily demand of patients and health professionals. For the remaining text, demand on the hospital pharmacy or dispensary will be called end-user demand. Hospital pharmacies and dispensaries at clinics need to maintain records of all distributed health care goods and are a reliable source of demand data.

Collection of one set of demand data, for example once a month, from each health care facility limits the overall amount of data which needs to be collected and allows using fairly simple information management systems. Collected demand data must be accurate in order to allow accurate forecasting.

Where end-user demand is not available because health care facilities are not keeping accurate records or because demand data cannot be transmitted, demand data from similar health care facilities in the area or the country can be used as a reference. Demand data from other complex political emergencies can also serve as a reference. If no historic demand data is available, forecasting will have to resort to estimates (Steinbuch, P.A. 2001, 9) by health programme managers.

When replacing provision of kits by individual items, the contents of the kits can be used to forecast future demand at the item level.

Since collection of daily end-user demand data would generate large amounts of data which need to be processed, demand data should be aggregated in weekly or

monthly time buckets (Stadtler, H., and Ch. Kilger (ed.) 2002, 154). Daily demand aggregation would only be useful if daily orders can be placed. However these would require processing a large number of orders and would make transport consolidation difficult. The use of monthly aggregate demand from assisted health care facilities also has the advantage that it can be calculated manually and does not require electronic data processing.

With the exception of occasional direct deliveries from supplier to health care facilities, humanitarian organizations are faced with multi-echelon systems (figure 5.5). An echelon refers to the distribution centre itself as well as all the downstream distribution centres and customers it supplies (Minner, St. 2000, 70).

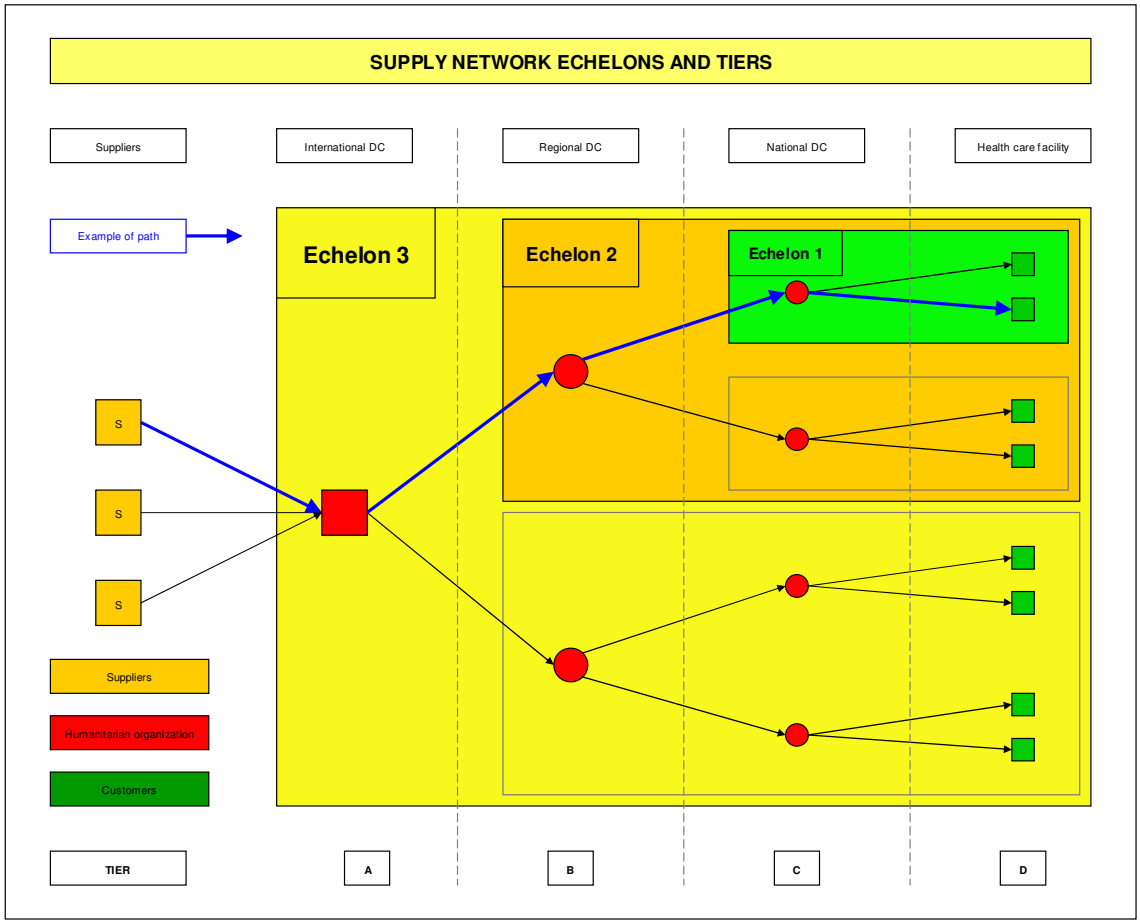

Figure 5.5 Supply network echelons and tiers

If forecasts at different tiers of the supply network are based on demand data from immediate downstream stores, due to demand distortion, forecasting accuracy will decrease with every upstream tier (Lee, H.L., V. Padmanabhan, and S. Whang 1997, 98). However if end-user demand is used for forecasting at all tiers, forecasting accuracy will increase with every upstream tier as demand is aggregated over a larger geographic area (Gudehus, T. 1999, 217) and the number of customers served by each distribution centre increases upstream.

If a periodic review inventory control policy is used, the forecast has to be made for at least the review period and the expected order cycle ahead. The forecasting accuracy for a period of time in the future (for example in five weeks for weekly demand) decreases with increasing time horizon (Stadtler, H., and Ch. Kilger (ed.) 2002, 154). On the other hand the aggregation of demand over a longer period

increases forecasting accuracy (Simchi-Levi, D., Ph. Kaminsky, and E. Simchi-Levi 2003, 310).

As demand in complex political emergencies generally can be highly variable, supply networks should be as flexible and responsive as possible in order to maximize forecasting accuracy by minimizing the forecasting horizon.

The forecasting method should be simple as otherwise sophisticated information systems are required, specialist staff needs to be recruited and a lot of training is required. Moreover sophisticated forecasting methods do not outperform simpler ones (Makridakis, S., St.C. Wheelwright, and R.J. Hyndmann 1998, 562) and staff may be reluctant to use forecasting methods which are not understood.

Forecasting accuracy can also be improved by combining different methods such as judgmental estimates and statistical analysis (Makridakis, S., St.C. Wheelwright, and R.J. Hyndmann 1998, 537). Depending on the availability of end-user demand data and the context different forecasting methods can be applied (figure 5.6).

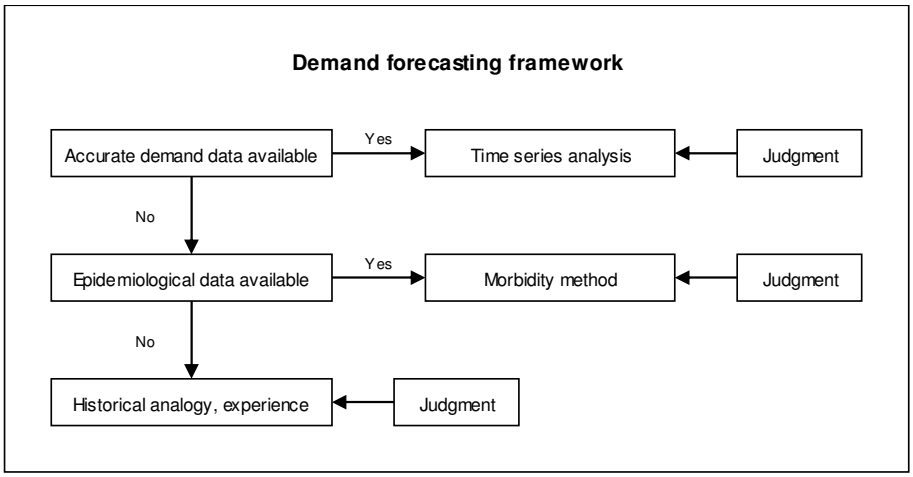

Figure 5.6 Framework for demand forecasting

Time series analysis is suitable for short-term forecasting of a large number of items (Silver, E.A., D.F. Pyke, and R. Peterson 1998, 86). Demand data from stock records must be corrected (Steinbuch, P.A. 2001, 58) by removing stock movements caused by removal of expired goods, theft, losses as well as damaged stock to avoid distorting end-user demand. Exponential smoothing methods are superior to moving averages but require more complex calculations as well as a rational for determining smoothing factors. The use of moving averages is appropriate for constant demand, linear trends as well as for intermittent demand (Koether, R. (ed.) 2004, 95) and therefore suits the needs of humanitarian assistance.

Considering seasonality of demand is difficult in the context of complex political emergencies as it would require demand data from at least the past three years (Steinbuch, P.A. 2001, 59) and changes in the conflict and situation of the health care system make it difficult to compare data from such a long period. Moreover seasonality of demand is relevant for communicable diseases (Perrin, P. 1996, 149) but does not affect demand for health care goods required for surgery. However judgment can be used to take seasonal patterns of certain medical conditions into consideration (Ockwell, R. A. 1994, 72) and correct forecasts.

Multivariate time series methods forecast an independent variable and apply a known relationship between the independent and dependent variable to forecast the dependent variable (DeLurgio, St.A. 1998, 21).

A forecast of the number of people injured by the consequences of armed conflicts allows determining the number of surgical kits which are designed to treat a defined number of people. Collecting data on the number of admissions to health care facilities or patient treated in outpatient departments allows determining trends and forecasting the overall needs for health services.

The morbidity method forecasts demand for drug products by multiplying the forecast for expected cases for a specific medical condition with the quantities of drug products of the standard treatment protocol (Quick, J.D. (ed.) 1997, 196). Treatment protocols indicate the type of drug product, the required strength as well as the quantity required for the entire treatment course of one patient. The forecasts for the most prevalent medical conditions in a population are added up to calculate overall needs. At least during the emergency phase of humanitarian assistance programmes, health care services should focus on medical conditions which cause excess morbidity and mortality (The Sphere Project 2004, 259). For example 50-95% of mortality among refugees is caused by only four communicable diseases (Hanquet, G. (ed.) 1997, 124), diarrhoeal diseases, acute respiratory infections, measles and malaria.

The expected number of cases of the medical condition, for example malaria, still needs to be forecasted. Incidence rates for the most common diseases should be available from standardized health information systems which are established and maintained by humanitarian organizations providing health services (The Sphere project 2004, 270). The number of expected cases for each medical condition can then be calculated by multiplying the size of the population with the incidence rate. However not all patients may seek medical treatment or have access to health care facilities.

Another possibility is to monitor the percentage of patients diagnosed with a certain medical condition at a health care facility. The forecast for the total number of patients treated every month multiplied with the percentage of patients with a certain medical condition allows forecasting the number of expected treatment episodes.

Where data is not yet available from epidemiological surveillance systems, forecasts can be based on epidemiological data from populations subjected to similar conditions (Quick, J.D. (ed.) 1997, 202) such as armed conflict and displacement. Since medical needs in complex political emergencies are similar to those in peace times (Perrin, P. 1996, 301) epidemiological data from before the conflict can serve as an indication of expected health needs.

While the morbidity method is suitable for forecasting at peripheral health care facilities it cannot be easily applied to hospitals and surgical interventions. The number of war-wounded cannot be predicted (Perrin, P. 1996, 221) and the needs for anaesthetics, sutures, drains, dressing material etc. cannot be standardized as they very much depend on individual patients.

On a global level crude forecasts for the kind and quantities of required health care goods can be forecasted from the context and using historical analogies and experience.

The type of conflict and type of weapons used in the conflict allows forecasting the type of prevailing injuries which can be expected. Knives and machetes will cause cuts and deep flesh wounds, gunshot wounds can be expected where small arms are used, shelling and bombing will cause crush injuries and fractures, use of incendiary devices burns and use of anti personnel mines will require amputations (Perrin, P. 1996, 224). However the biggest cause of mortality in complex political emergencies is not trauma from direct effects of the armed conflict but rather the high rates of infectious diseases (Guha-Sapir, D., and W.van Panhuis 2002, 19).

Outbreaks of some communicable diseases can be expected in large populations especially when they live in crowded and poor sanitary conditions (Perrin, P. 1996, 125).

Measles is highly contagious, can rapidly spread in crowded conditions and is a major cause of death in nearly all refugee situations (Simmonds, St., P. Vaughan, and S.W. Gunn (ed.) 1986, 137). In order to prevent an epidemic, vaccinating children against measles is a priority in emergencies affecting large, displaced and malnourished populations (The Sphere project 2004, 276). The size of the population together with demographic data allows estimating the number of children and determining the number of doses of measles vaccine which are required for a mass vaccination campaign. The need for measles vaccines also implies the need for establishing an effective and reliable cold chain. At the same time, the demand for vitamin A tablets, which must be administered to every vaccinated child (The Sphere Project 2004, 275), can be forecasted.

The primary causes of morbidity in less developed countries and displaced populations are measles, diarrhoeal diseases, acute respiratory infections, malnutrition, and where endemic malaria (Hanquet, G. (ed.) 1997, 145). These can also be expected in less developed countries affected by complex political emergencies.

Displacement and general lack of food not only cause malnutrition but make children more susceptible to infections (Perrin, P. 1996, 126) and also aggravate other medical conditions. Two out of three people killed in relation to armed conflict during the past 15 years were children (Denny, Ch. 2005, 155).

The need for treating wounded can be expected in the immediate aftermath of fighting while communicable diseases or malnutrition will develop and increase after fighting has ceased especially where populations are displaced and live in increasingly crowded conditions.

Changes in demand caused by unpredictable circumstances or events cannot be forecasted by any statistical methods and require qualitative forecasting methods such as human judgment (Silver, E.A., D.F. Pyke, and R. Peterson 1998, 124).

Consequently logistics managers must collect and analyse information on political developments, conflict dynamics as well as the conditions in which assisted populations live.

Demand for health care services can change due to external factors such as sudden increase or decrease of conflict intensity, population displacement, denial or granting of access to conflict areas as well as improvement or degradation of living, sanitary and nutritional conditions of assisted people.

Increase or decrease in donor funding, entry or exit of other humanitarian actors or changes in health care programmes can also change demand suddenly.

Arriving at a realistic forecast requires combining statistical and judgmental forecasting methods as well as experience (Makridakis, S., St.C. Wheelwright, and R.J. Hyndmann 1998, 503).

Where demand data is available from health care facilities with fairly stable demand, forecasting time series analysis will allow tailoring humanitarian assistance as closely as possible to needs and considering national treatment protocols as well as practices. This quantitative forecast needs to be combined with and corrected by qualitative forecasts for expected changes in demand related to the armed conflict.

If no demand data is available, epidemiological data on the incidence of the most prevalent diseases as well as on the number of injured people can be used for multivariate time series analysis and the morbidity method. Again forecasts need to be adjusted by qualitative forecasts.

At the beginning of an emergency and where people in need are not yet accessible, humanitarian organizations will have to resort to forecasts based on demand data from accessible health care facilities near the conflict area. Where this data is not available qualitative forecasting based on similar complex political emergencies in the past and experience will have to be used. Likewise determining stock levels of emergency stocks will require experience from previous complex political emergencies as well as judgment.

5.3.2 Inventory control

A rational and structured system for calculating safety stocks and replenishment orders is needed at the level of each health care facility as well as at each distribution centre operated by humanitarian organizations. This chapter will consider only the external supply chain as generally the overall value of purchased goods is not large enough for suppliers to adjust their inventory control policies to demand from humanitarian organizations. The global operations of humanitarian organizations will require a multi-echelon system and inventory control policies must aim at minimizing demand distortion.

Decisions concerning inventory control policies must consider their impact on safety and security risks throughout the supply network and will therefore favour consolidating consignments into less frequent shipments.

Inventory control policies must be effective and provide required service levels to end-users reliably and consistently but should be simple and take the limitations of available human and technical resources in the field into account.

In a multi-echelon supply network the inventory control policy of the most downstream stock needs to be given the greatest attention as it generates the demand signal for the supply network and any distortion will adversely affect all of its upstream tiers.

The inventory control policy at health care facilities must be as simple as possible as qualified staff and computers will usually not be available. As electricity supply is often unreliable, inventory control systems must be workable manually.

Demand of health care goods consumed by patients or used by health care professionals in out-patient departments, wards, sterilization departments, operation theatres, laboratories etc. must be distorted as little as possible in the pharmacy placing replenishment orders to humanitarian organizations. Consequently health care facilities should have as little tiers in their internal supply network as possible as any buffer stock, for example in hospital wards, will distort demand. Ideally the actual daily needs for each hospital department are delivered directly from the hospital pharmacy. In clinics and dispensaries no demand distortion should occur as drug products are dispensed directly from the pharmacy to patients according to their prescriptions.

If pharmacies are too small to keep all stocks in one place, any reserve stock must be treated together with the main stock as one entity rather than as two separate tiers which would inevitably distort demand.

A periodic review system allows temporal aggregation and consolidating shipments from distribution centres (Chopra, S., and P. Meindl 2004, 440) as well as limiting

resources for calculating replenishment orders. However a hastening level can be set for each item to place additional replenishment orders between reviews (Tagaras, G. and D. Vlachos 2001, 415) or to request expediting backorders in order to avoid stockouts.

The imprest system (Jessop, D., and A. Morrison 1994, 80) is the simplest inventory control policy which adjusts to changes in demand and a simple form of a (R, S) inventory control policy. First only items which are regularly used and suitable for the level of care should be stocked and replenished (Kaur, M. et al. 2005, 190). At regular intervals the difference between the defined reorder level and the stock on hand is ordered (Silver, E.A., D.F. Pyke, and R. Peterson 1998, 363). If the reorder level is not changed, the replenishment lead time is shorter than the review period and no items are backordered, the order pattern is equal to the demand pattern and demand is not distorted (Boute, R.N., et al. 2005, 700).

If end-user demand changes significantly, the reorder level needs to be adjusted. However in order to minimize demand distortion, the reorder level should only be changed if either shortages occurred during the last review period or stock levels have increased so far that stock is in danger of expiring in the health care facility. Consequently reorder levels can be maintained for the majority of items and demand distortion can be eliminated at this tier for most items. Necessary increases of reorder levels must be made instantly to avoid a recurrence of the shortage and the amplification of end-user demand is unavoidable. However any decrease in reorder levels can be made gradually in order to smooth demand variability. This will temporarily lead to higher stock levels than with an instant change of the reorder level but not decrease service levels.

Even when the reorder level is changed, demand distortion could be entirely avoided by calculating replenishment orders based on the previous reorder levels and transmitting this set of data as end-user demand for forecasting at all tiers of the upstream supply network. In a second step the order quantities for the items with changed reorder levels are calculated with the new reorder levels and forwarded to the humanitarian organization as replenishment orders. Since the order quantity exceeds average end-user demand, the next upstream distribution centre will have to distribute part of its safety stock to fill the entire order. In the next period the replenishment order will have to include the quantity to replenish safety stocks and it will take as many review periods as the supply network has tiers to replenish all safety stocks. Nevertheless the larger order quantity from the health care facility does not affect calculation of the reorder level at any tier of the supply network and therefore does not cause any upstream demand amplification.

If the separate transmission and processing of demand data and order data is not possible, demand amplification is inevitable but order variability can at least be dampened by adapting smoothing replenishment policies (Boute, R.N., et al. 2005, 700). However the multiplication of order quantities with a smoothing factor cannot be calculated manually and is therefore not adapted to limitations of health care facilities.

The imprest system also has the great advantage that it only requires performing a physical stock count at the end of each review period and one subtraction for each item to calculate the replenishment order. Neither computers nor sophisticated stock records are necessary, staff can be easily trained and the system can be implemented very quickly in emergencies. Although initially determination of reorder levels has to be based on an estimate of future demand, thereafter regular collection and analysis of demand data is not required.

Humanitarian organizations must supply assisted health care facilities regularly and reliably. If pharmacists lose confidence, they will create "phantom demand"

(Gattorna, J. 1998, 191) by increasing order quantities even if demand has not increased. Filling orders from health care facilities only partially can lead to the "rationing game" where customer orders are exaggerated beyond actual needs in the hope that a certain percentage will be delivered and cause demand distortion (Lee, H.L., V. Padmanabhan, and S. Whang 2004, 1879).

Humanitarian organizations have the means to maintain information systems as well as recruit and train qualified staff. Since assisted health care facilities rely on regular and reliable supply, humanitarian organizations must maintain safety stocks and minimize the probability of stockouts.

By definition emergency stocks at any tier of the supply network should be available at any time and therefore replenishment orders need to be placed as soon as any goods are issued. This corresponds to a continuous review system and a (S-1, S) policy (Grahovac, J., and A. Chakravartny 2001, 580).

As demand data is not available when assistance commences, several health care facilities may be supplied, demand may be highly variable and stocks must be maintained at several tiers of the supply network, a more sophisticated inventory control policy is needed at distribution centres operated by humanitarian organizations.

The use of global information rather than local information on demand at each tier of the supply network, allows minimizing demand distortion (Christopher, M. 1998, 218), increasing forecasting accuracy and customer service (Lee, H.L., K.C. So, and Ch.S. Tang 2000, 262). The use of local information leads to a multiplicative, the use of global information only to an additive increase in variance of demand (Simchi-Levi, D., Ph. Kaminsky, and E. Simchi-Levi 2003, 108).

In a base stock control system (Silver, E.A., D.F. Pyke, and R. Peterson 1998, 489) end-user demand from health care facilities is regularly collected, transmitted upstream along the entire supply network and aggregated for each echelon. As the number of assisted health care facilities increases upstream with each echelon, the variability of overall demand decreases through aggregation, increases forecasting accuracy and allows reducing safety stock levels (Gudehus, T. 1999, 221). Sharing of demand information is often associated with EDI but demand information can also be communicated by less sophisticated means such as fax (Lee, H.L., K.C. So, and Ch.S. Tang 2000, 262).

In a multi-echelon system with all tiers using a (S-1, S) inventory control policy, any stock issue at a health care facility would immediately lead to replenishment of one unit at all levels of the supply network (Svoronos, A., and P. Zipkin 1991, 68) without any demand distortion. However this would require replenishment ordering and transport every time goods are issued from stock.

In a steady state multi-echelon system with an Equal Time Supplies policy (Silver, E.A., D.F. Pyke, and R. Peterson 1998, 244) or fixed reorder levels and (R, S) inventory control policies, constant replenishment lead times, constant review periods, constant safety factor and with level end-user demand at all assisted health care facilities, reorder levels as well as cycle and safety stock at all tiers remain unchanged and aggregate end-user demand is shifted upstream to each tier of the supply network without any demand distortion (see figure 5.7). If end-user demand is not level, it will be distorted by the required increases and decreases of safety stock levels at all upstream tiers of the supply network in any case.

Moreover the Equal Time Supplies policy is not recommended as it is considered as a "simple-minded approach" (Silver, E.A., D.F. Pyke, and R. Peterson 1998, 244). When a service level method is applied, demand distortion is inevitable since, even if end-user demand is level, safety stocks will change with the standard deviation of

demand which cannot be realistically assumed as constant even if all other parameters remain constant. Consequently demand distortion can only be minimized but not eliminated.

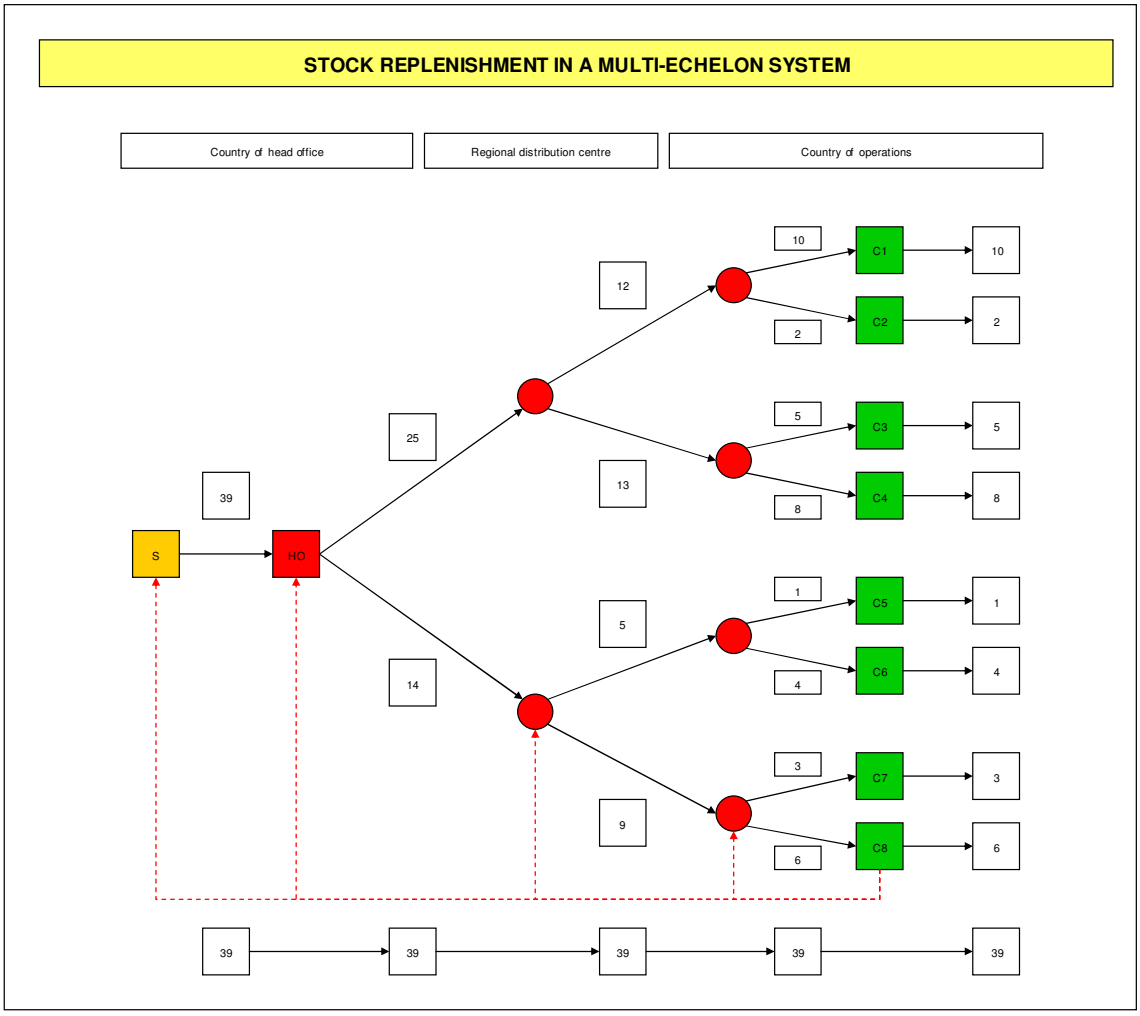

Figure 5.7 Example of stock replenishment in a multi-echelon system

As health care facilities use a periodic review system, the amount of data is far smaller than in a continuous review system. In order to aggregate demand of each echelon regularly, assisted health care facilities must use the same review periods and times, for example the end of each month. The use of end-user demand along the entire supply network requires a reliable communication network which allows distributing data quickly throughout the entire supply network. Ideally end-user demand will also be shared with commercial suppliers of humanitarian organizations for their own demand forecasting.

Base stock control systems are also more responsive to large changes in end-user demand. In a multi-echelon supply network where every tier uses a periodic review system as well as local information and all tiers place replenishment orders at the same time, the increased demand would take as many review periods to propagate to the most upstream tier as the supply network has tiers.

The use of end-user demand allows to quickly detect step changes in demand and to immediately adjust stock levels at all tiers of the supply network. Correct calculations require collection of data from all assisted health care facilities and excluding demand

from health care facilities which is filled from other supply sources such as other humanitarian organizations or the government.

The use of global information and centralized control yields the best solutions (Silver, E.A., D.F. Pyke, and R. Peterson 1998, 11) but coordination and information throughout the entire supply network is a challenge even in highly developed countries.

Because of the use of mainly manual stock records at assisted health care facilities as well as lack of reliable telecommunications infrastructure, centralized control in the context of complex political emergencies is not realistic. Moreover a central decision maker would hardly be able to consider the context and constraints of individual distribution centres in dozens of different countries. While use of global information requires only the transmission of end-user demand, centralized control would require full visibility of all relevant information such stock on hand, customer orders, backorders, losses, returns, lead times and remaining shelf life at all distribution centres. If inventories were controlled centrally, a reliable and fast telecommunications system would be required to transmit instructions for replenishment orders and shipments downstream throughout the entire supply network again. Distribution centres also must not become completely dependent on telecommunications infrastructure which may be damaged or switched off. Unlike large data files, limited amounts of information such as a replenishment orders can be transmitted through backup telecommunications systems such as radio networks or as hardcopies which are sufficient for local control.

Consequently control must be decentralized and every distribution centre must determine parameters such as safety stock levels and apply its inventory control policy using global information but calculating replenishment orders according to the local situation.

Continuous review systems require less safety stock to provide the same level of customer service (Chopra, S., and P. Meindl 2004, 325). However inventory positions have to be monitored continuously or at least reviewed after each transaction. Continuous review systems imply frequent replenishment orders for a small number of items which require more frequent transport of small consignments which cannot be consolidated.

Periodic review system are advantageous as they allow to review all items held in stock together as well as to consolidate replenishment orders and stocks can be replenished with weekly or monthly shipments. In the emergency phase where demand is not known and highly variable, daily reviews might be needed while later replenishment orders can be calculated weekly or monthly.

Replenishment lead times from upstream distribution centres should be as short as possible in order to reduce demand distortion (Simchi-Levi, D., Ph. Kaminsky, and E. Simchi-Levi 2003, 109) and make the supply network more responsive. However the trade-off between shorter replenishment lead times and higher transport costs needs to be considered. Moreover some elements of replenishment lead times such as delays caused by customs clearance are often difficult to influence.

While cycle stocks must cover demand during the review period as well as replenishment lead time, safety stocks are needed to hedge against variability in demand as well as supply (Bowersox, D.J., and D.J. Closs 1996, 68).

Safety stocks based on equal time supplies may be widely used and intuitively appealing but disregard the difference of variability among different items (Silver, E.A., D.F. Pyke, and R. Peterson 1998, 244) and therefore do not provide good protection against stockouts.

Minimizing costs is less important than ensuring availability of health care goods and therefore service level models must be preferred.

The determination of the type of demand distribution requires sophisticated analysis and has little influence on safety stock calculations (Gudehus, T. 1999, 211). Instead normal distributions can be used as a good approximation (Silver, E.A., D.F. Pyke, and R. Peterson 1998, 122).

Selection of the safety factor has to consider the trade-off between service level and storage costs (Christopher, M. 1998, 54). Since humanitarian organizations provide only essential health care goods, stockouts cannot be calculated in terms of lost sales and must be avoided. However, ensuring 100% stock availability would require maintaining large safety stocks. Alternatively a service level of around 97% can be maintained and shipments expedited in case the hastening level is reached. Although transport costs for expediting are high, a reliable system for express deliveries allows reducing the costs for maintaining safety stocks (Tagaras, G. and D. Vlachos 2001, 417).

Another method of avoiding stockouts at customers without increasing safety stock levels at supplying distribution centres is to only partially fill orders from several customers when stock levels are insufficient to fill all customer orders and backorder the balance.

With a periodic-review, order-up-to-level (R, S) inventory control policy the order quantity is determined by subtracting the inventory position from the reorder level which in turn is calculated by adding cycle stocks and safety stocks. In order to avoid having to open supplier packing, the calculated order quantity should be adjusted to a multiple of packing sizes of the respective item. The slight increase in order quantities will not cause any demand distortion as long as end-user demand rather than demand from the next downstream distribution centres is used for forecasting (Thorn, J. 2002, 18).

Level	Inventory control policy
Health care facility	Imprest system
Distribution centres	(R, S)
Emergency stocks	(S-1, S)

Table 5.1 Summary of inventory control policies

It is a common practice to apply different inventory control policies to different classes of items (Lambert, R.S., and J.R. Stock 1993, 426). Pareto analysis is not useful in the context of humanitarian assistance as it does not consider the consequences of stockouts (Lonergan, E. 2003, 129), no profits are made and quantifying lost sales in financial terms is not relevant. Moreover the turnover of items does not necessarily correspond to their importance and criticality. Just as the stockout of an inexpensive screw can stop a production line, the stockout of an inexpensive syringe could be life threatening (Jessop, D., and A. Morrison 1994, 158).

Since humanitarian organizations provide mainly essential health care goods, the highest possible service level should be provided. However some items are more critical than others and some items, even if essential, can be substituted by others without jeopardizing the quality of provided health care services.

The VEN system distinguishes between vital (V), essential (E) or nonessential (N) drug products (Quick, J.D. (ed.) 1997, 630) but can equally be applied to other health care goods. V-items must be on hand at all times, essential items must be supplied with a high service level while nonessential items can be ordered from the supplier as needed.

The XYZ-analysis differentiates items according to the regularity and forecasting accuracy of their demand (Gudehus, T. 1999, 225) as runners, repeaters and strangers. Since x-items have a high turnover and demand is regular, they can be forecasted with high accuracy and do not require keeping large safety stocks. Heavy and bulky items with level demand can be ordered at longer intervals and shipped with cheaper and slower modes of transport. For example regional distribution centres could order infusions and dressing material, which are delivered from international distribution centres by sea, three or four times a year in order to reduce transport costs.

Y-items display high variability and require larger safety stocks while demand of Z-items is erratic and highly unpredictable. Since demand distribution of Z-items does not resemble a normal distribution, safety levels methods will not yield good results. Consequently forecasts for Z-items must be adjusted by judgment. For vital items, such as drug products or essential replacement parts, stocks may have to be maintained even if demand is small and very irregular.

5.3.3 Stock positioning of items

For each stock item a decision must be taken at what tier or tiers of the supply network it should be permanently stocked (Toomey, J.W. 2002, 128). At one extreme, items are not stocked anywhere along the supply network but made to order by the manufacturer upon an order by a humanitarian organization for a specific health care facility (figure 5.8). At the other extreme stocks of health care goods are maintained at all tiers of the supply network. In multi-echelon networks storage of the full range of products at all tiers is usually not justified (Bowersox, D.J., and D.J. Closs 1996, 486).

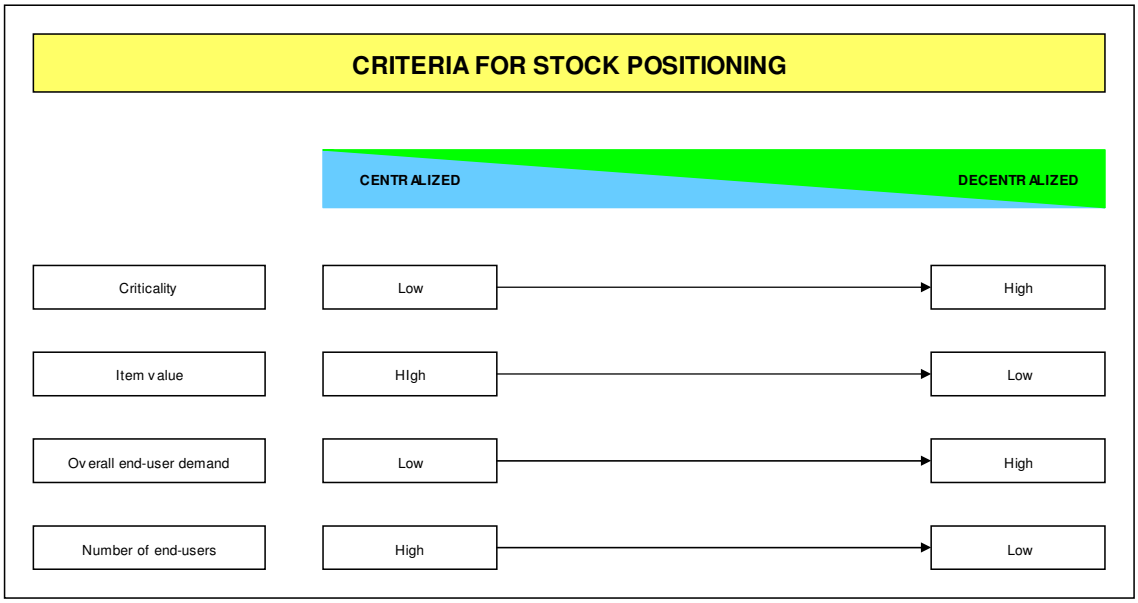

Figure 5.8 Criteria for stock positioning

Logistics managers must consider the trade-off between responsiveness of replenishing downstream stores by stocking items at all tiers and the cost of overall network stocks. Centralization of stocks reduces overall stock levels as well as stock holding costs (Christopher, M. 1998, 134).

Moreover at a given level of end-user demand any increase in network stocks decreases overall turnover and therefore reduces remaining shelf life of health care goods upon delivery to the end-user. Increasing network stocks of slow moving items, such as health care equipment, ties up capital which does not immediately benefit end-users and carries the risk of obsolescence and therefore loss of funds. Donors expect their funds to benefit people in need and will not appreciate funding stocks which remain idle in a store.

Health care goods which are critical and cannot be substituted must be held decentrally in order to ensure stock availability and high service levels.

Items with high value such as expensive health care equipment should be kept centrally (Simchi-Levi, D., Ph. Kaminsky, and E. Simchi-Levi 2004, 68) in order to reduce the financial resources which are tied up throughout the network as well as to reduce the risk of loss or damage. The low turnover and therefore small number of orders justifies using expensive express delivery services directly to assisted health care facilities.

Items with overall low end-user demand (and therefore more erratic demand) should preferably be held centrally in order to increase stock turnover and avoid expiry caused by holding items at all tiers with low turnover (Bowersox, D.J., and D.J. Closs 1996, 464).

A small number of end-users implies overall low turnover and favours decentralized positioning directly at the end-users without keeping any safety stocks upstream.

Essential expendable health care goods with high turnover need to be stocked at all tiers of the supply network in order to avoid stockouts, ensure quick replenishment from upstream stores as well as to ensure high service levels at end-users (figure 5.9).

All assisted health care facilities must have a backup for all essential equipment which will allow them to continue services until a replacement is delivered directly from the supplier. Equipment can fail any time and delivery of replacement equipment from suppliers may be impossible immediately because of security constraints.

Health care equipment with low demand and high value (for example diagnostic imaging equipment) should be kept centrally, preferably with the manufacturer or supplier, in order to avoid tying up capital as well as risking that equipment becomes obsolescent.

In order to avoid the risk that stocks are not available with the supplier immediately when demand occurs, humanitarian organizations can make an agreement with the manufacturer or supplier to reserve a certain quantity which is immediately available at all times. By this humanitarian organizations do not tie up capital but also are guaranteed to always receive the newest models. Availability of health care goods with suppliers at all times should be an important criterion for selecting suppliers in the first place.

Essential health care equipment with medium value and turnover such as oxygen concentrators or suction machines should be kept at international or even regional distribution centres in order to reduce lead times.

Finally health care equipment of low value and high turnover such as sphygmomanometers or simple diagnostic equipment should be kept at national distribution centres

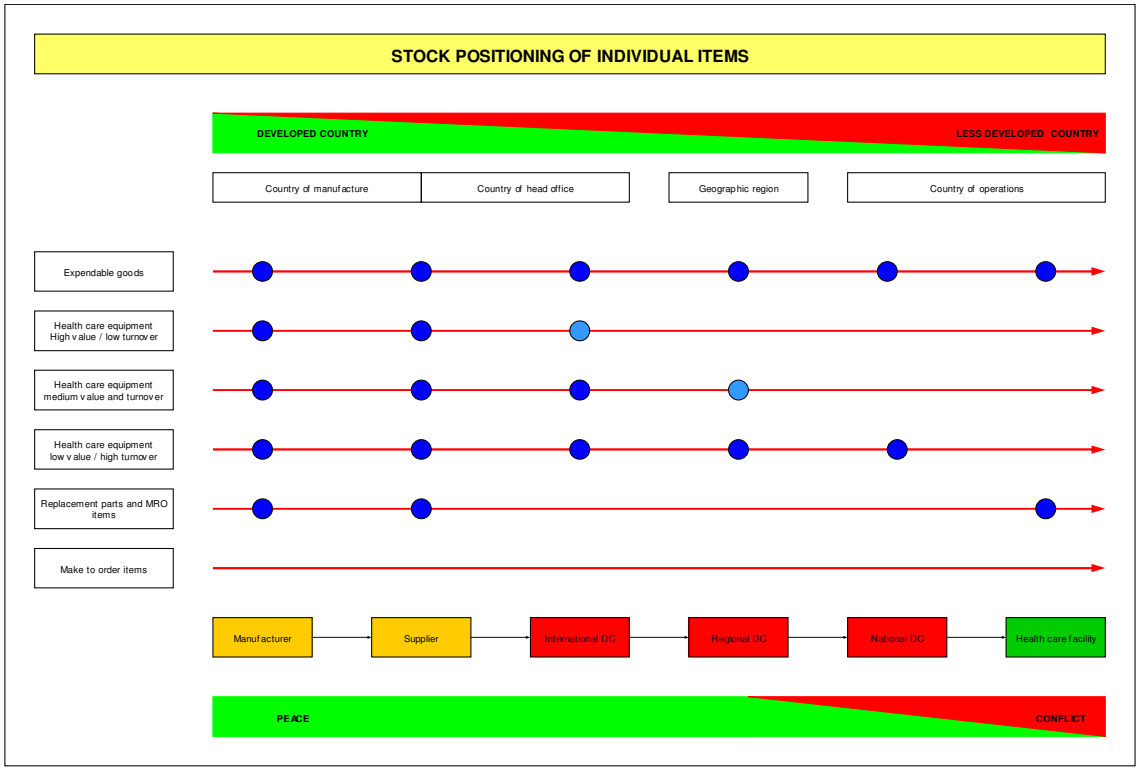

Figure 5.9 Stock positioning of individual items

Critical replacement parts as well as maintenance, repair and operating (MRO) items must be kept at the assisted health care facility in any case to ensure continuous operation of any critical and essential health care equipment. Because of the great variety of health care equipment of all assisted health care facilities worldwide, demand of individual replacement parts and MRO items for a specific type and model of health care equipment will be low and erratic. Therefore health care facilities should maintain sufficient stocks to cover weeks or months of lead times from suppliers.

The erraticness of independent demand for replacement parts can be converted into dependent demand by replacing certain parts according to predetermined schedules even if they are not broken.

5.3.4 Contingency stock positioning

Keeping contingency stocks centrally at the international distribution centre reduces storage costs, increases turnover and decreases the risk of expiry and obsolescence. However lead times for delivery to assisted health care facilities anywhere in the world also increases.

The other extreme of keeping large contingency stocks at all international, regional as well as national distribution centres would increase the overall value of network stocks considerably and lead to frequent losses of goods from expiry of unused emergency stocks.

The alternative to the above static systems is a dynamic approach with different phases and repositioning of contingency stocks throughout the network according to an early warning system and anticipation of emergencies.

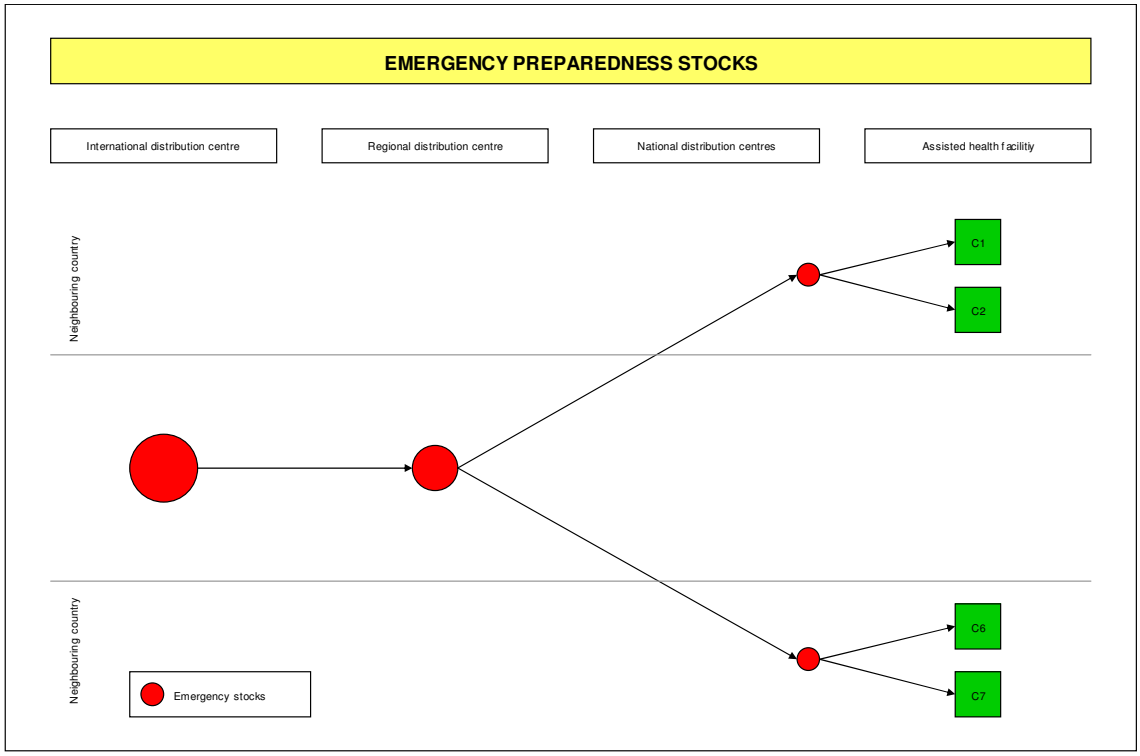

Figure 5.10 Emergency preparedness stocks

Worldwide contingency plans should be planned with full visibility of all contingency stocks within the supply network. The stock levels of contingency stocks must be adjusted to the expected lead time for providing contingency stocks from the next upstream store. If the national distribution centre expects a replenishment lead time of 48 hours from the regional distribution centre, it must hold sufficient contingency stocks to supply health care facilities for the same period of time.

During the emergency preparedness contingency phase no immediate emergency is foreseeable and humanitarian organizations have to be prepared to intervene anywhere in the world at short notice (figure 5.10). In order to reduce overall stock levels, the main emergency stocks are held at the international distribution centre, some stocks are held at regional distribution centres and smaller emergency stocks at national distribution centres for emergency response to already supported health care facilities.

Humanitarian organizations need to closely monitor political developments globally and identify potential crisis regions. As soon as a crisis is anticipated in a country, contingency stocks are immediately shifted downstream through the network towards the crisis area (figure 5.11). If the humanitarian organization has not been providing humanitarian assistance in the country where an emergency is imminent, then a national distribution centre for holding contingency stocks needs to be established quickly. This will reduce lead times and avoid delays through customs clearance, congested or blocked borders when the emergency stocks are requested.

Establishing contingency stocks in the country where a crisis is anticipated does not only have the advantage of shorter lead times in case of an intervention but

establishing national distribution centres allows to assess the context of working in the country, learning about customs procedures and assessing constraints of logistics infrastructure in the country.

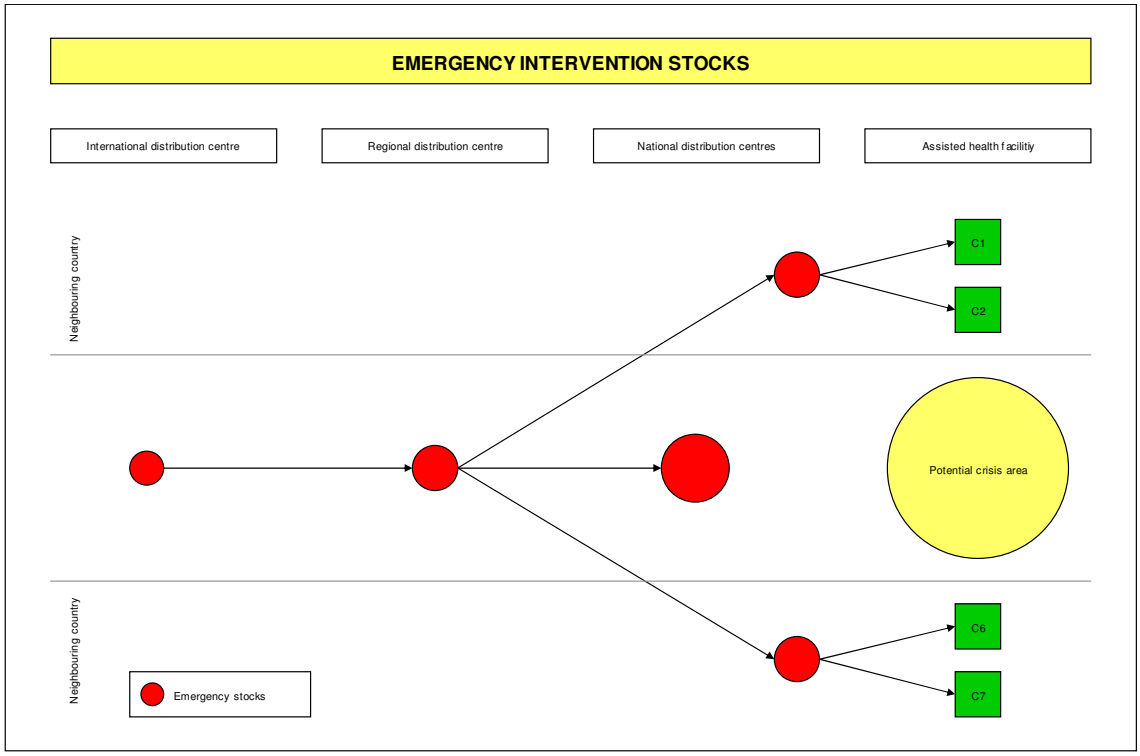

Figure 5.11 Emergency intervention stocks

Contingency plans need to be regularly updated (WFP 2001, 4) and the size of emergency stocks will depend on the likelihood of the crisis as well as the expected number of people which are likely to require assistance

If the crisis area can be supplied from neighbouring countries, all national distribution centres must increase their contingency stocks as well. This will allow increasing the overall capacity to respond as well as to resort to alternative supply channels in case the main channel is blocked by parties to the conflict or due to security constraints. If the humanitarian organization is already providing assistance in the potential crisis area, stock levels at assisted health care facilities can be increased or additional contingency stocks established.

At the same time orders must be placed to suppliers to replenish upstream contingency stocks as quickly as possible to be prepared for any other emergency.

As soon as the humanitarian organization decides to intervene, health care facilities which provide assistance to people in need can be supplied (figure 5.12). While emergency assistance is provided, all distribution centres must monitor increased demand and adjust their stock levels in order to continue assistance when the emergency supplies are depleted.

If contingency stocks are not needed, they can be shifted backwards through the supply network and be maintained for future emergency preparedness.

This dynamic approach carries the risk that transport and storage resources are used for moving contingency stocks near to potential crisis areas but are eventually not used. However this disadvantage is balanced by the advantage of reducing network

stocks as well as reducing lead times and increasing responsiveness in case of an emergency.

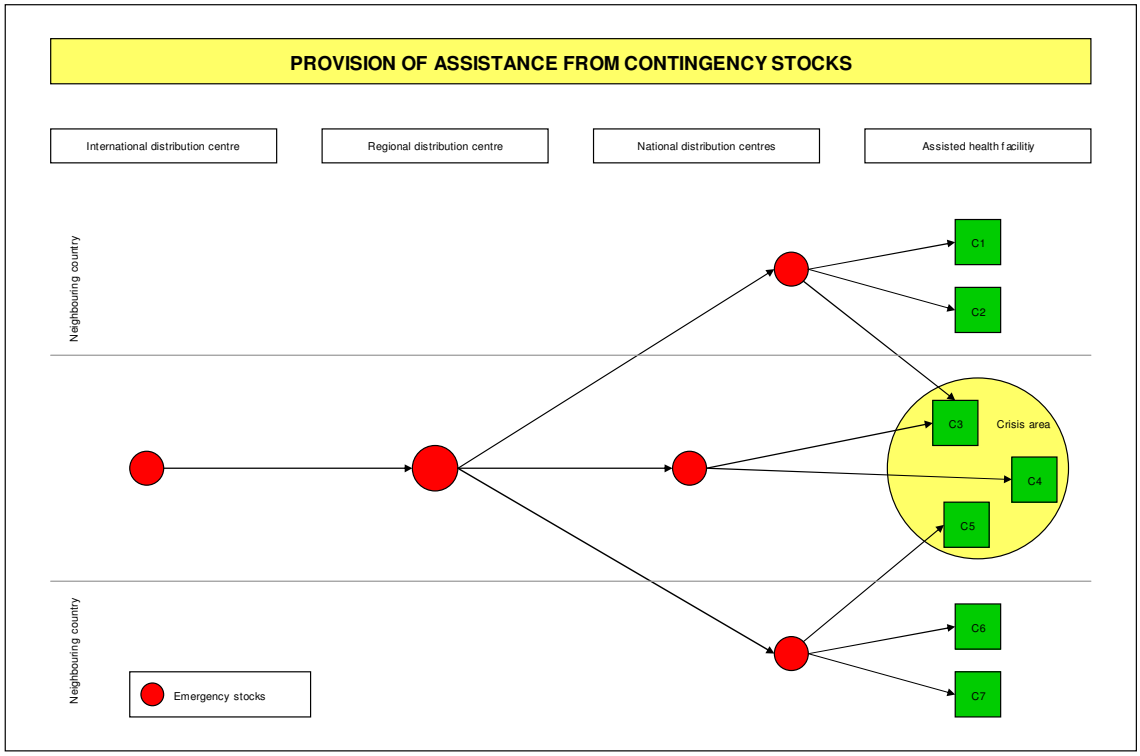

Figure 5.12 Provision of assistance from contingency stocks

Once assistance programmes have been established, humanitarian organizations must maintain emergency response stocks at national distribution centres as well as assisted health care facilities to prepare for sudden increases in demand at assisted health care facilities caused by increased severity of the conflict or population movements.

5.4 Physical distribution

Within the strategic distribution framework, humanitarian organizations must decide on a tactical level on the distribution system within available physical distribution channels and select the modes of transport which provide the best service to humanitarian assistance programmes. Moreover to what extent transport capacities should be outsourced and what means of transport should be selected for in-house transport.

5.4.1 Distribution systems

Distribution operations can be differentiated by the extent to which consignments are processed and transformed at the distribution centres as they flow down the supply network. Consignments shipped directly to end-users bypass distribution centres and are not processed. Transhipped consignments are only temporarily stored at distribution centres but are not transformed and leave the distribution centre as they have arrived. Cross-docked goods are processed in a distribution centre without put-away or order picking. Finally warehousing is the classical distribution strategy where

goods are put away, stocked and picked for filling specific customer orders (Simchi-Levi, D., Ph. Kaminsky, and E. Simchi-Levi 2003, 133).

Directly shipped goods flow through the established network but bypass at least one node, avoiding multiple handling, receiving, put-away, order picking, packing and shipment (figure 5.13).

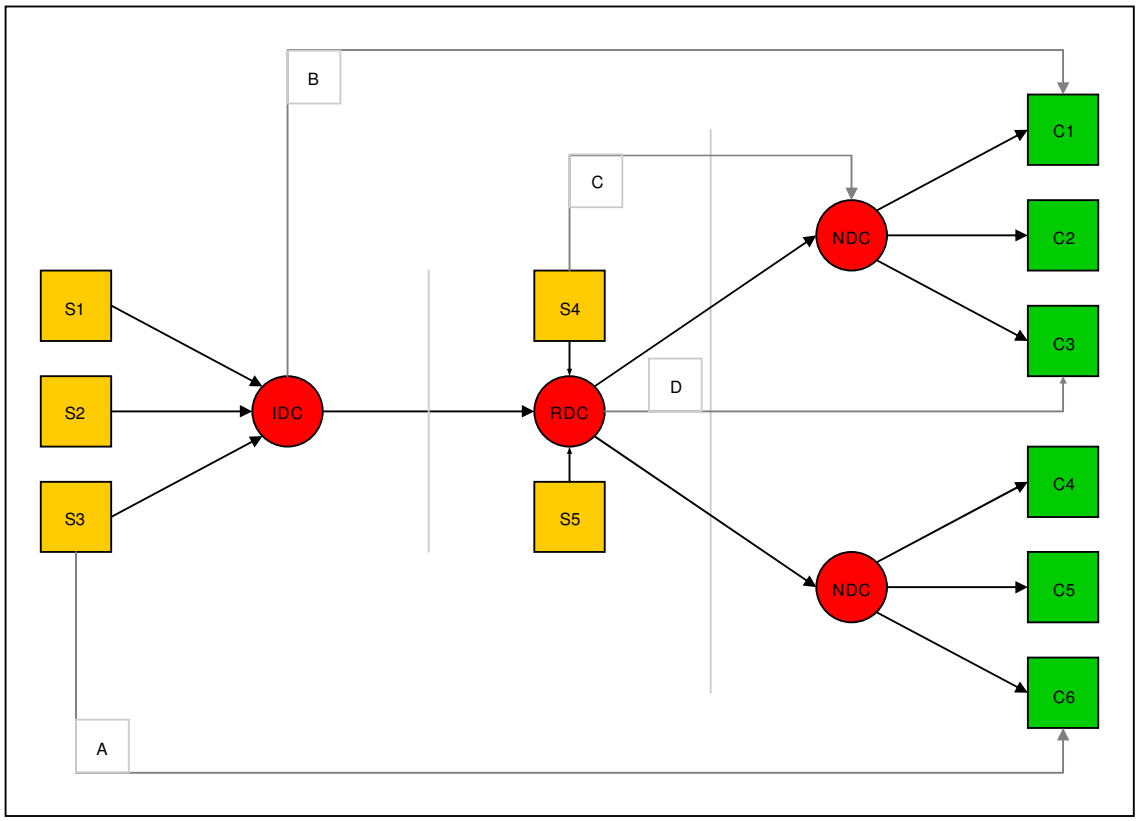

Figure 5.13 Direct shipment

For example drop shipments (Burt, D.N., D.W. Dobler, and St.L. Starling 2003, 345) of equipment which is delivered from a supplier directly to an assisted health care facility (A) or from a supplier near a regional distribution centre directly to a national distribution centre (C). Likewise humanitarian organizations may bypass facilities within their own supply network for example by delivering consignments from the international distribution centre (B) or a regional distribution centre (D) directly to an assisted health care facility.

For urgent orders and in emergencies lead times can be reduce by shipping health care goods, which are not yet stocked at distribution centres upstream from assisted health care facilities, directly from a manufacturer or an international distribution centre to the end-user. Moreover management of direct shipments require less resources and shipped health care goods can be tracked more easily than when flowing through a complex supply network. Direct shipments also have the advantage of eliminating demand distortion (Lee, H.L., V. Padmanabhan, and S. Whang 2004, 1883).

Since the delay caused by stock rotation at every tier of the supply network reduces the remaining shelf life, direct shipments may be necessary for health care goods with short total and remaining shelf life.

Direct shipments will also be preferred if transport costs between supplying stores and end-users are low, such as replacement parts or small pieces of equipment, and

humanitarian organizations can therefore not gain any significant benefits from transport consolidation by using the established supply network. For example for countries with regular and cheap commercial international flights, supply directly from an international distribution centre may be more cost-efficient than through a regional distribution centre in the vicinity of the country receiving humanitarian assistance.

Direct shipments can also be used for health care goods which are not stocked at all tiers of the supply network and for which overall channel inventories should be kept low. For example expensive health care equipment, rarely used replacement parts or health care goods which are provided only once. Sensitive and fragile health care goods can be shipped directly in order to minimize handling and therefore reduce the probability of their damage.

Direct shipments reduce the possibility of benefiting from transport economies between several suppliers and the end-user (Bowersox, D.J., and D.J. Closs 1996, 483) and increase the number of consignments which need to be cleared by customs. Moreover direct shipments also reduce the volume of goods flowing through the established supply network and therefore reduce their efficiency. For example direct shipments from an international distribution centre to a national distribution centre will reduce lead times but also reduce the turnover of health care goods at the regional distribution centre supplying the national distribution centre.

Moreover goods which are stored along the supply network but are shipped directly for example during an emergency reduce the stock turnover at the stores which are bypassed. This can lead to expiry especially of emergency stocks.

Transhipped consignments are received and temporarily stored at distribution centres without being processed and entire consignments leave the distribution centre in the same configuration as they have arrived.

Transhipment may be necessary when the modes of transport are changed but cannot be fully synchronized. For example consignments arriving with a commercial carrier at an international airport may require temporary storage in a distribution centre until the next road convoy is scheduled to deliver to end-users.

Transhipment is also useful for consolidating shipments of several consignments (Stadtler, H., and Ch. Kilger (ed.) 2002, 195) and reducing transport costs, especially for international air or sea transport over long distances. For example consignments for several different customers which are packed at a regional distribution centre are received at a national distribution centre for separation and onward distribution to their respective final destination.

Transhipment is also necessary when the capacities of modes of transport for successive shipping legs differ. For example if consignments are transported by truck to a national distribution centre but can be transported to end-users only by small all-terrain vehicles, small boats or small aircraft.

Since humanitarian organizations usually support only a limited number of health care facilities and these do not require large amounts of goods, cross-docking will rarely be a suitable distribution system. However cross-docking may be considered where a fairly large number of health care facilities are supplied by a small number of suppliers such as wholesalers and kind and quantities of provided health care goods are known before purchasing. In this system each supplier delivers one consignment for each health care facility to a transhipment depot. For each health care facility the consignments from different suppliers are received, combined and consolidated into a single shipment for delivery to their final destination (Bowersox, D.J., and D.J. Closs 1996, 394). This distribution system allows consolidating outbound shipments rather than having each supplier deliver small consignments to each customer

(Chopra, S., and P. Meindl 2004, 422). Where humanitarian organizations supply assisted health care facilities according to a rationing system with fixed quantities of defined goods, maintaining stocks is no longer necessary.

At distribution centres where stocks are permanently maintained, consignments will generally be put away after receiving in order to ensure stock rotation and avoid expiry of goods in stock. Transhipment of goods from an upstream distribution centre to end-users without put-away and order picking would in principle increase efficiency but also reduce turnover of stocks and therefore increase the risk of expiry before use. Therefore all items which are permanently stocked at a distribution centre need to be put-away even if orders for the same item need to be filled at the time of arrival.

Lateral transhipments are transfers of goods between facilities within the same tier of the supply network (Grahovac, J., and A. Chakravartny 2001, 582). They may be considered when the distance or transport time between two stocks at the same tier is shorter than between the upstream stock and the stock facing a shortage (Lee, H.L. 1987, 1302).

Lateral transhipment (figure 5.14) between two national distribution centres (A) may be warranted in case of shortages or in order to reduce excess stocks (Shawkey, P., and C. Hart 2003, 75). Health care facilities may also share stocks (B) in case the upstream supply network is disrupted and the distribution centre is unable to fill orders.

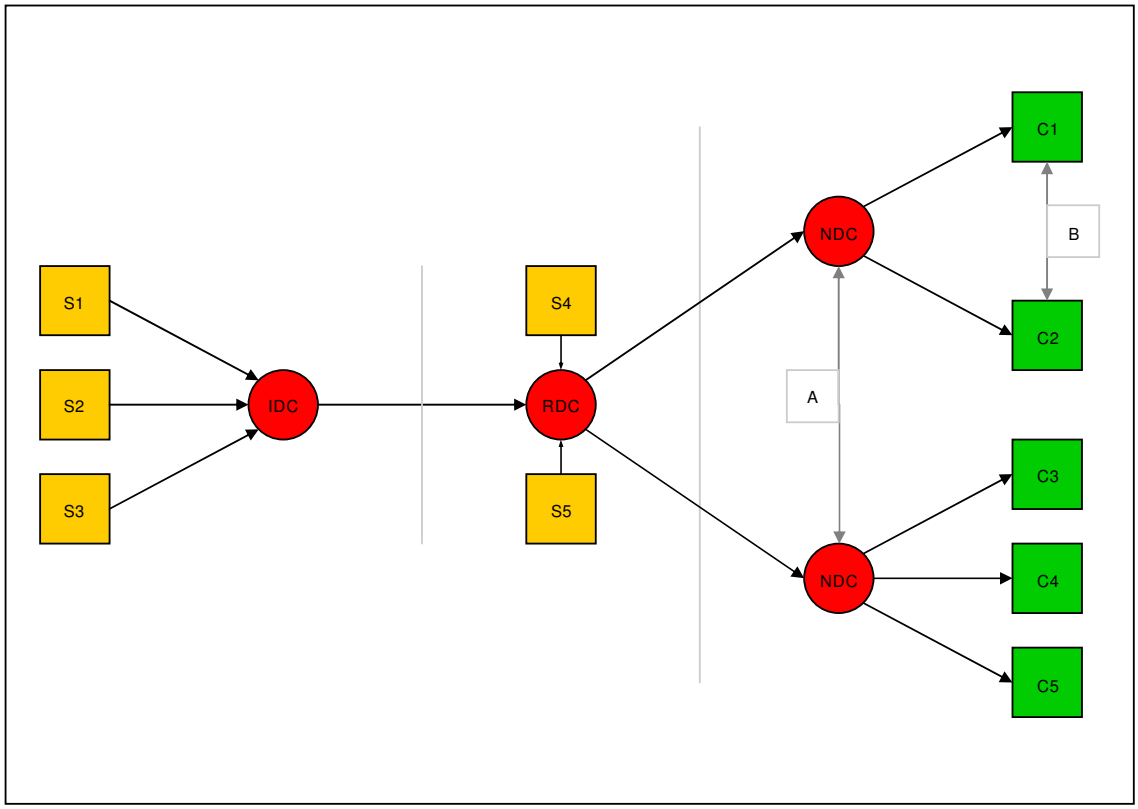

Figure 5.14 Lateral transhipment

As mentioned in chapter 5, humanitarian organizations require a "fast track" in case of shortages or impending stockouts. A system for rapid distribution of small consignments should be established in advance and separate from the standard distribution system (Koether, R. (ed.) 2004, 58).

Expediting shipments (Jessop, D., and A. Morrison 1994, 54) requires decisions on whether commercial or humanitarian networks are used, whether to ship consignments directly as well as which combination of modes of transport can minimize transport times.

Commercial express delivery services offer the advantages of picking up goods, high speed, reliability of transport and final delivery, tracking of consignments and possibly customs clearance in the country of delivery (Steinbuch, P.A. 2001, 288). On the other hand express delivery services are expensive and limit the weight and volume of consignments.

While express delivery services are effective at the international and regional level, services will be unavailable in most countries with ongoing complex political emergencies. Therefore humanitarian organizations must establish a system for final delivery with their own aircraft or vehicles which are available at short notice.

5.4.2 Selection of mode of transport

At the level of supply chain planning, selection of a mode of transport will depend on the situation and context in the country or area where humanitarian assistance programmes are being implemented, availability of means of transport, customer service requirements as well as characteristics of consignments and health care goods (European Commission 1998d, 67).

For international distribution, which requires multimodal transportation, decisions on the mode of transport and the length of their respective legs are required.

The same mode of transport may be used for entire consignments or differ according to certain characteristics of health care goods.

While the selection of modes of transport is also an operational decision, tactical decisions are necessary where mid- or long-term contracts are concluded with carriers (Chopra, S., and P. Meindl 2004, 425).

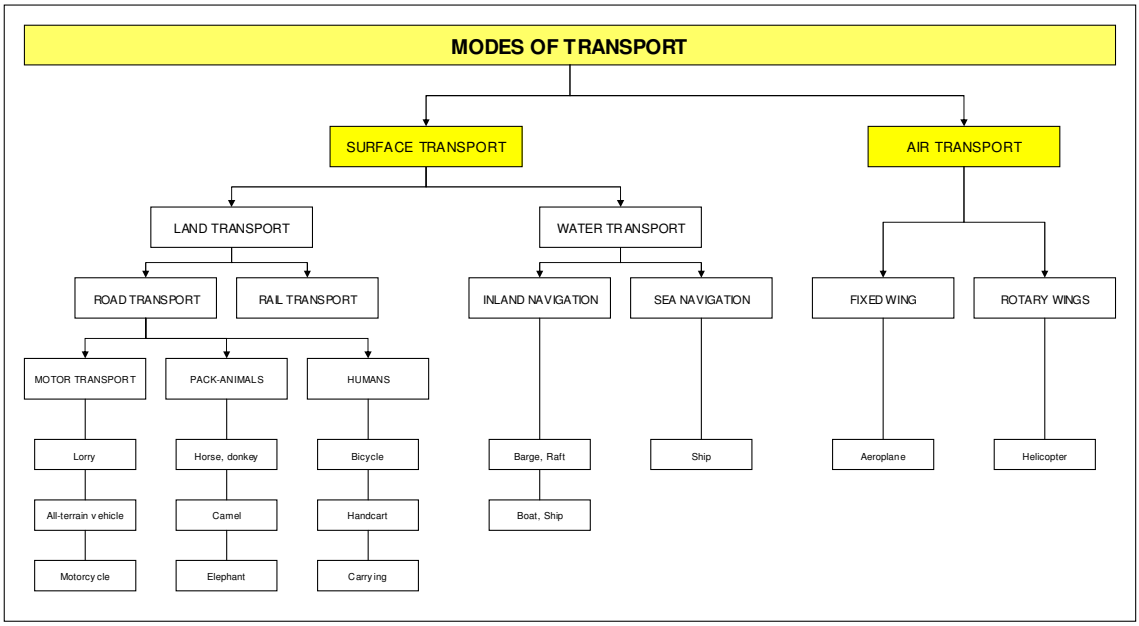

Figure 5.15 Modes of transport

Mode of transport	Advantages	Disadvantages
Motor transport	General availability of road networks General availability of vehicles and drivers Low cost Fairly fast Flexibility Point-to-point delivery No restrictions on type of goods Transport of large volumes and weights Possibility of temperature control Possibility to move pallets and containers Security of consignments	National legislation and regulations Often poor quality of road networks Congestion of roads Congestion of border crossings Often no transport during the night possible Vulnerable to attacks and looting Vulnerable to mines
Pack-animals	Low cost Do not require roads No need for fuel or replacement parts	Slow Limited capacity Need to split consignments Special protection from weather required
Humans	Availability Low cost Do not require roads	Hard work Requires providing sufficient food Limited capacity Need to split consignments Difficulty of tracking consignments
Rail transport	Very low cost Fairly fast Transport over long distances possible Transport of large volumes and weights Exact schedules Reliability Low probability of congestion	Limited networks Possibly high prices through monopolies Often poor quality of services Possibly infrequent services Only terminal-to-terminal delivery possible Damage through shunting Risk of blocked routes Vulnerable to attacks and looting
Water transport	Low cost Reliability Transport of large volumes and weights	Slow Dependency on schedules Requires multiple handling Limited to water ways and the sea Requires sea ports Dependency on meteorological conditions
Air transport (fixed wing)	High speed Can cover long distances Can overcome obstacles Reliability Safety of consignments Little danger of damage to consignments Security (compared to land transport)	Limited number of airports and airstrips Dependency on schedules Possibly low frequency Dependency on meteorological conditions Limited capacity of small aircraft Strictly regulated industry Requires overflight and landing permission Requires registration and licensing Requires air traffic control services Dependency on authorities Requires high quality fuel Requires sophisticated maintenance Potential problem of airline safety Vulnerable to attacks High costs for war risk insurance Potential congestion at airports Requires multiple handling of consignments Possible delays through custom sclearance
Air transport (helicopters)	Fairly high speed Flexibility Independence from infrastructure	Very high cost Low payloads High maintenance requirements

Figure 5.16 Advantages and disadvantages of different modes of transport

Apart from the traditional modes of motor transport by road, rail, water and air (Pfohl, H.Ch. 2000, 167), transport with bicycles, pack-animals and transport by people need to be considered (figure 5.15). Pipelines are practical only for transport of water over short distances. Advantages and disadvantages of different modes of transport are summarized in figure 5.16.

Road networks, although of varying extent and quality, as well as motor vehicles, fuel and drivers are available in most inhabited places in the world. However road conditions may restrict the size of motor vehicles which can be used and for some routes only expensive all-terrain vehicles can be used. National legislation and regulations concerning vehicles and drivers, with which humanitarian organizations must comply, may pose constraints but are often weak and not enforced.

In terms of capacity, routing and scheduling road transport offers the greatest flexibility (European Commission 1998d, 69). Road transport can cover long distances, is comparatively cheap, fairly fast and allows transporting large consignments from the supplier directly to the customer without any need for further handling or any restrictions on schedules. Door-to-door delivery also reduces the risk of parcels being lost or shipped to the wrong destination.

Temperature sensitive goods can be heated or cooled during transport. Large, heavy and bulky goods as well as dangerous goods such as compressed gases or flammable liquids can be transported by road. Trucks allow moving and transporting entire unit loads such as pallets or shipping containers quickly.

Consignments are fairly well protected from theft as vehicles can be sealed, the driver is accountable for complete delivery and goods cannot be lost during change of mode of transport.

Transport times can be increased significantly by congestion, especially at border crossing points as well as adverse weather conditions. Poorly maintained roads increase safety risks for drivers and may require use of expensive all-terrain vehicles.

Roads can easily be mined or blocked by parties to the conflict or criminals, motor vehicles are vulnerable to military attacks and looting and use of road transport during the night is often too dangerous.

Where roads are not available, pack-animals such as horses, donkeys, mules, camels or elephants allow to transport goods through mountainous or dessert terrain and shallow rivers at low cost. Transport is independent of fuel and replacement parts although fodder might have to be carried to feed the animals along their itinerary.

However pack-animals are slow, their load capacity is limited (PAHO 2001, 112) and consignments have to be split into small loads and loaded on each pack-animal.

People can transport goods on bicycles, carts (UNHCR 2000, 256) or by carrying loads. People are always available, no assets or infrastructure are required and transport costs are low. While goods can be transported in remote areas, through jungles or steep terrain, the capacity is limited, transport is slow and distances limited. The splitting of consignments into many small parcels (Dörner, G. (ed.) 1992, 26) makes tracking and tracing difficult. Moreover people must be well nourished and be provided with adequate and sufficient food.

Rail transport is fairly fast, independent of road networks and their quality, very cost efficient and allows transporting large volumes and weights over long distances (Ehrmann, H. 2003, 25 and Stabenau, H. 2004, 214). Transport is carried out according to predetermined schedules and rail networks are not as prone to congestion as road networks.

However rail networks are often limited and inflexible in less developed countries, loading and unloading is restricted to railheads and the quality of equipment and services is often poor (European Commission 1998d, 70). Humanitarian organizations are dependent on schedules and possibly infrequent services. Where a single operator, for example a state company, offers services, prices may be unreasonably high. Transport from a supplier to a customer requires at least three legs, multiple handling and goods are prone to damage through shunting shocks (Rushton, A., J. Oxley, and Ph. Croucher 2000, 341).

Rail roads can easily be damaged and blocked, unlike vehicles trains cannot drive round obstacles and are vulnerable to attacks and looting.

Water transport is very cost efficient over long distances, can move large volumes and weights (European Commission 1998d, 70), is fairly reliable and, except for canals, waterways do not require maintenance. Small boats are very flexible and a fairly fast means of transport.

However transport by ships and boats is limited to navigable rivers, lakes, canals as well as coastal water and the sea (Lambert, R.S., and J.R. Stock 1993, 173), may be restricted by water levels and meteorological conditions, fairly slow and usually dependent on schedules. Larger ships require port infrastructure for loading and unloading, consignments must be double-handled and significant delays can be caused by port operations as well as customs clearance (Chopra, S., and P. Meindl 2004, 419).

The main advantages of air transport are its speed and reliability which allow reducing safety stocks (Pfohl, H.Ch. 2000, 172) as well as the ability to cover long distances. Moreover air craft can overcome obstacles such as mountains or damaged roads, can travel directly to their destination and operate in remote areas without any other transport infrastructure (Jones, K. 2005, 92).

The danger of damage to and pilferage of consignments is comparatively low and less sturdy packing is required (Pfohl, H.Ch. 2000, 172). Except during take-off and landing, aircraft are not very vulnerable to attacks with unsophisticated weapons.

However air transport is expensive, limited by available airports and airstrips and dependent on meteorological conditions (European Commission 1998d, 67). The frequency of scheduled flights may be quite limited for certain routes and significant delays can occur when transport is postponed due to lack of transport capacity. Small passenger aircraft, which are often used by humanitarian organizations, have limited capacity for cargo and flights can be restricted by meteorological conditions.

Air transport is a heavily regulated industry and the use of airspace requires approval of the respective state authorities (Kummer, S., and H.-J. Schramm 2004, 218). Air operations generally require air traffic control services and aircraft as well as crews require registration and licensing in the country of operation. Consequently the operation of air craft is heavily dependent on authorities who can deny overflight and landing rights at any time.

Aircraft require careful maintenance by qualified staff as well as high quality fuel. Where national authorities are absent or do not enforce regulations, use of commercial air carriers can be risky. Aircraft are very vulnerable to attacks, even with unsophisticated weapons, during take-off and landing and the high cost of aircraft incurs high costs for war risk insurance. Some goods cannot be transported for security reasons at all (for example compressed gases) or only in limited quantities.

Transport is delayed by customs clearance (Rushton, A., J. Oxley, and Ph. Croucher 2000, 341) and overall transport time is increased by the need for multiple handling for

transporting consignments to and from airports. Especially in acute emergencies airports often are bottlenecks which become congested and can cause significant delays for transport.

Criteria for selecting a mode of transport can be related to external factors, customer service requirements as well as physical attributes of goods and consignments (Rushton, A., J. Oxley, and Ph. Croucher 2000, 343). The characteristics of different modes of transport will also influence their selection in a given context and under given constraints.

The availability of infrastructure such as road and rail networks, ports or airports as well as transport means, operators such as pilots, maintenance facilities and fuel are external constraints for the selection of means of transport. Humanitarian organizations may be forced to use cheaper and slower modes of transport due to lack of funding (PAHO 2001, 110) or may prefer using scarce financial resources for other purposes.

The ease of obtaining and the risk of revocation of permits such as licences for vehicles or overflight and landing rights are important considerations even where means of transport are readily available. For example the use of aircraft is more prone to interference by authorities or parties to the conflicts than road transport. Delays for customs clearance at international airports as well as multiple handling can lead to overall longer transportation times than using road transport for the same route.

The primary concern in selecting modes of transport is the security of staff, goods and assets. The ease and likelihood of attacks as well as theft of goods need to be considered. Depending on the situation, air transport may be safer where attacks on road convoys are likely or more unsafe where parties to the conflict have the means of attacking aircraft.

Safety of staff is a further important consideration. For example humanitarian organizations may refrain from using commercial air carriers because of their poor safety records.

The complexity, required resources, capacity and cost for operating different means of transport can also be a determining factor. Although aircraft, especially helicopters, may be the preferred mode of transport in a given context, the required resources for ensuring safe operations, air traffic control, obtaining clearances, managing the aircraft, providing replacement parts and high quality fuel may be prohibitive.

The flexibility, frequency of scheduled transport and reliability are also important considerations (Bowersox, D.J., and D.J. Closs 1996, 325). Road transport is much more flexible than air transport since it does not require obtaining clearances. The use of small aircraft may be the preferred means of transport but limit the size and load unitization of goods. The use of daily road transport services may be faster than commercial air transport with unreliable schedules or which is available only once a week. Air transport schedules are prone to changes at short notice due to changes in priority of consignments.

The overall convenience of the entire transport operation from the supplier to the customer as well as the environmental impact of means of transport also needs to be considered.

Selected modes of transport, especially for the final leg, must be effective and allow serving a customer in a given location. In extreme situations pack-animals or small boats may be the only means of transport which allow serving a customer.

The distance between supplier and customer as well as the lead time required by customers also determine the selection. The need to accurately track and trace (critical) goods favours use of express services even where lead time is not critical.

Unpredictability of demand (Pfohl, H.Ch. 2000, 173) and high criticality of items favour use of faster means of transport. As discussed above, maintaining a service level below 100% requires a fast distribution mode, even at higher costs. While routine consignments for stock replenishment are shipped with a slow mode, expediting goods for which the hastening level is reached or urgently requested non-stock items require a fast mode of transport combined with direct shipment to the end-user. Combining two modes of transport allows benefiting from lower transport costs for the majority of demand while maintaining responsiveness by using a fast mode of transport when needed (Moinzadeh, K., and St. Nahmias 1998, 761).

The volume and weight of annual demand, rather than for an individual item, as well as annual transport costs are important considerations. Heavy and bulky equipment but rarely ordered items such autoclaves may warrant use of air transport while slower and cheaper modes of transport will be preferred for small and light items, such as disposable syringes, with high annual transport volumes. However the trade-off between annual transport and annual storage costs (Chopra, S., and P. Meindl 2004, 425) as well as requirements to minimize stock levels must also be considered.

The volume, weight, size and shape of items need to be considered (Gattorna, J. (ed.) 1990, 326) and may exclude certain modes of transport such as the use of small aircraft or pack-animals. In general high value items will warrant use of more expensive modes of transport. The density and value density rather than the volume or weight per item unit may determine the mode of transport (Rushton, A., J. Oxley, and Ph. Croucher 2000, 338). For example air transport may be warranted for an expensive vaccine but not for a low value item with the same weight such as a bandage. On the other hand light weight and bulky but expensive items may nevertheless warrant air transport. Road transport will be favourable for light but bulky items such as disposable syringes.

Air transport of health care goods with certain characteristics such as compressed gases, volatile anaesthetics, flammable or corrosive goods may be prohibited or limited to maximum amounts. Even where air transport is possible, the availability and cost of specialized packing may favour surface transport.

The susceptibility of certain health care goods to temperature and humidity (Dörner, G. (ed.) 1992, 17) as well as a short remaining shelf life favours faster means of transport while susceptibility to physical damage favour more gentle transport by air or small vehicles.

Goods prone to theft, such as valuable items or drug products subject to international control, require transport with the most secure mode of transport.

The overall weight and volume of consignments as well as the load unitization also determine suitable modes of transport.

Logistics managers need to first consider the most secure and safest modes of transport and then select the mode of transport which allows providing the required customer service at the lowest possible cost (Rushton, A., J. Oxley, and Ph. Croucher 2000, 336).

Outside the crisis area the most efficient mode of transport should be chosen. Within the crisis area the safest rather than the fastest or most efficient mode of transport should be selected. Air transport may be safer than crossing through the conflict area

by road. On the other hand civilian aircraft may easily become targets and therefore be unsafe to operate.

The main objective of logistics managers in the crisis area is to minimize the risk for staff, assets and goods during distribution. The priority is avoiding conflict related risks but safety risks caused by poorly maintained infrastructure such as roads or airports as well as unsafe means of transport, especially aircraft, must also be considered.

MODE OF TRANSPORT / REQUIREMENT / ATTRIBUTE	ROAD	RAIL	WATER	AIR
Availability of infrastructure				
Availability of transport means				
Availability of operators				
Availability of fuel and maintenance				
Scarcity of donor funds	●	●	●	
Restrictions by authorities and difficulties to obtain permits	●	●	●	
Ease of and time for custom clearance				
Security				
Safety				●
Low resources and complexity of operating transport means	●	●	●	
Requirement for large transport capacities				
High cost-efficiency	●	●	●	
Flexibility				
Frequency				
Reliability				
Overall convenience				
Environmental impact		●	●	
Effectiveness				
Long distance between supplier and customer		●	●	●
Requirement for short customer lead times	●			●
Need to reduce stock levels				●
Need for tracking and tracing	●			●
High annual transport volume and weight	●	●	●	
Unpredictability and high criticality				●
High volume and weight of items	●	●	●	
High value density				●
Requirement for special packing (dangerous goods)	●	●	●	
Susceptibility to damage by temperature	●			●
Susceptibility to physical damage				●
Perishability and short remaining shelf life				●
Susceptibility to theft and looting				
HIgh weight and volume of consignments	●	●	●	
Load unitization	●	●	●	

● Favours

Depends on context and situation

Figure 5.17 Selection criteria for modes of transport

The security and safety of transport takes priority over minimizing transport distances or transport time. Long detours, even taking several days, may be warranted to avoid security risks or the use of unsafe infrastructure such as a damaged bridge. Road transport may be preferred to available air transport if either aircraft or airport infrastructure are considered unsafe, even if transport time increases significantly.

Maintaining the quality of transported goods throughout the physical distribution process is also a priority. Sensitive health care goods must be protected from adverse effects such as heat, cold or physical damage during transport requiring use of faster modes of transport or use of special means of transport such as refrigerated containers.

Since availability of modes of transport and the context will change as goods are distributed through the supply network, generally several modes of transport will be used and require a decision where to change between modes of transport. Some considerations for selecting modes of transport are summarized in figure 5.17.

In order to avoid dependency, wherever possible an alternative mode of transport should be planned in case the preferred mode of transport is not available.

If slower modes of transport are used for routine replenishment of medical stores and health care facilities, provisions for expediting urgently needed consignments must also be established.

In a given context and situation, long distances between suppliers and customers, the requirement for short lead times and reduction of safety stock levels, the need to track and trace consignments, high unpredictability of demand, high value density, small consignments as well as susceptibility of goods to damage favour shorter transport times and therefore air transport. However because of its high cost the use of air transport should be considered carefully (Ockwell, R. A. 1994, 435), at least for transport between neighbouring countries as well as domestic transport.

High volumes and weights of items as well as annual distribution volumes, transport of hazardous goods, transport of palletized goods as well as the need to reduce transport costs favour the use of surface transport.

For several aspects such as reliability, flexibility or the susceptibility to theft and looting the most suitable mode of transport will depend on the circumstances and situation of the respective humanitarian assistance programme.

5.4.3 Outsourcing of transport capacities

Even humanitarian organizations which have taken a strategic decision to acquire and maintain their own means of transport, will rarely rely on in-house transport for distribution of all humanitarian assistance goods throughout their entire supply network. On the other hand complete outsourcing of all transport will not always be possible due to unavailability of means of transport or lack of security for commercial carriers.

While the criteria discussed in chapter 4.4.4 are valid, the context and situation will influence the tactical decision what transportation operations throughout the supply network to outsource. The geographic area and distance, characteristics of shipped goods as well as the required transport capacity are possible criteria for partial outsourcing (Steinbuch, P.A. 2001, 297).

Except for charter flights during the initial emergency phase, humanitarian organizations could not afford operation of their own aircraft and ships for all international transport. Because of the variability of transport volumes and lack of

freight on return trips, operation of transport means would also not be cost-efficient. Consequently humanitarian organizations need to use commercial transport up to the country where humanitarian assistance is provided and possibly for domestic transport to the crisis area.

Sourcing transport services for each consignment has the advantage of being able to select the carrier offering the best price and service but is also time consuming, especially for a large number of small consignments. Alternatively all international transport can be outsourced to a single carrier, provided the transport network extends to all or at least most of the countries where humanitarian organizations are providing assistance. Using services of a single carrier may increase transport costs for some shipments and lead to dependency, but also reduces time and resources for searching carriers and purchasing services. A single carrier can also be contracted for worldwide shipment of certain goods such as cold chain items.

Within the country and the crisis area where humanitarian assistance is provided, outsourcing of transport services can be considered provided that carriers are available and the security situation allows them to operate.

However the complete outsourcing of all transport also entails dependency on an often limited number of commercial carriers (UNHCR 2000, 255) and the sudden interruption of commercial transport would stop supply to assisted health care facilities. Moreover humanitarian organizations may have the competency for limited transport capacities in case of emergencies while commercial carriers might not be able to provide transport service at short notices in case of emergencies. On the other hand relying entirely on in-house transport resources also carries the risk of dependency and shortages in case of technical problems with transport means or staff shortages.

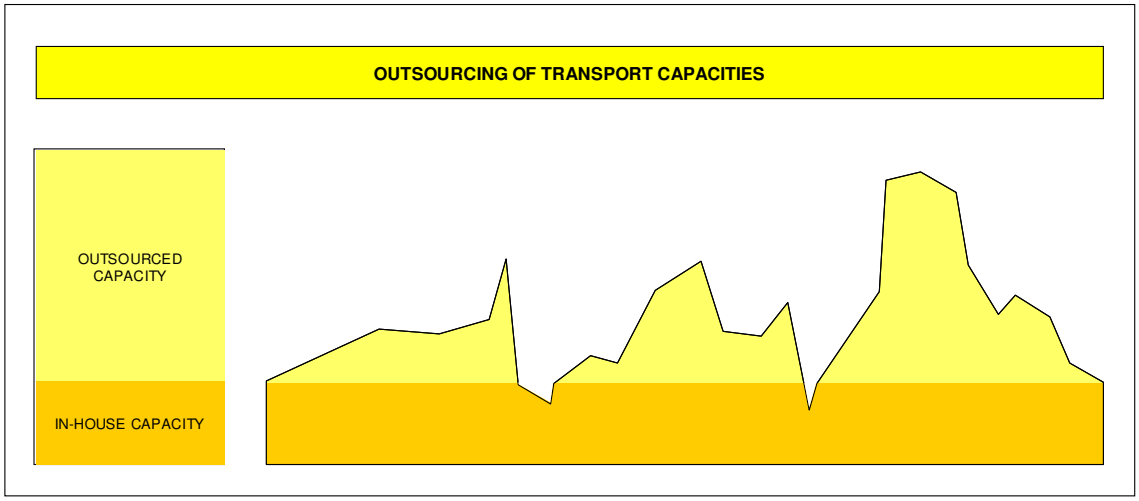

Figure 5.18 Outsourcing of transport capacities

Humanitarian organizations can find a compromise by combining in-house and outsourced transport capacities (Chopra, S., and P. Meindl 2004, 452). In-house transport capacities should ensure regular supply of assisted health care facilities at least with all essential health care goods even if transport costs are higher than for commercial transport. Maintaining transport capacities permanently also allows maintaining the resources and expertise for operations. Minimal transport capacities are also mandatory for ensuring an immediate response to emergencies as well as for evacuating or relocating staff at any time (Mayhew, B. 2004, 40).

Maintaining transport capacities which can cover only a part of overall transport requirements reduces the risk that transport resources are not used and increases the overall utilization of in-house transport. Transport capacities can be planned according to minimal needs while peaks are outsourced (Ockwell, R. 1994, 436) to commercial carriers (figure 5.18).

5.4.4 Selection of means of transport

Among the many issues which need to be considered for selection of transport means some have particular importance for the context of humanitarian assistance programmes. Generally the capacity and size of means of transport will decrease the further humanitarian assistance goods move downstream through the supply network (UNDAC 2000, chapter L, 2).

Wherever a choice is possible, the safest type of vehicle, boat and ship as well as aircraft should be selected. Safety is also of particular importance as any breakdown or accident in an insecure area increases the exposure to conflict related risks.

Means of transport must be adapted to the characteristics of goods, type of loads and be suitable for maintaining their quality by maintaining adequate temperatures and protecting them from damage during transport.

Selected types of transport equipment must be effective, reliable and flexible in the context and under the circumstances in which humanitarian assistance is provided and comply with national legislation and regulations. Vehicles commonly used in the country may be more suitable to the road conditions than more sophisticated vehicles from abroad (Weeks, Ch. 2005, 37).

Among different types of equipment which are suitable in the context and allow providing the same quality of services, the most cost-efficient should be selected (figure 5.19).

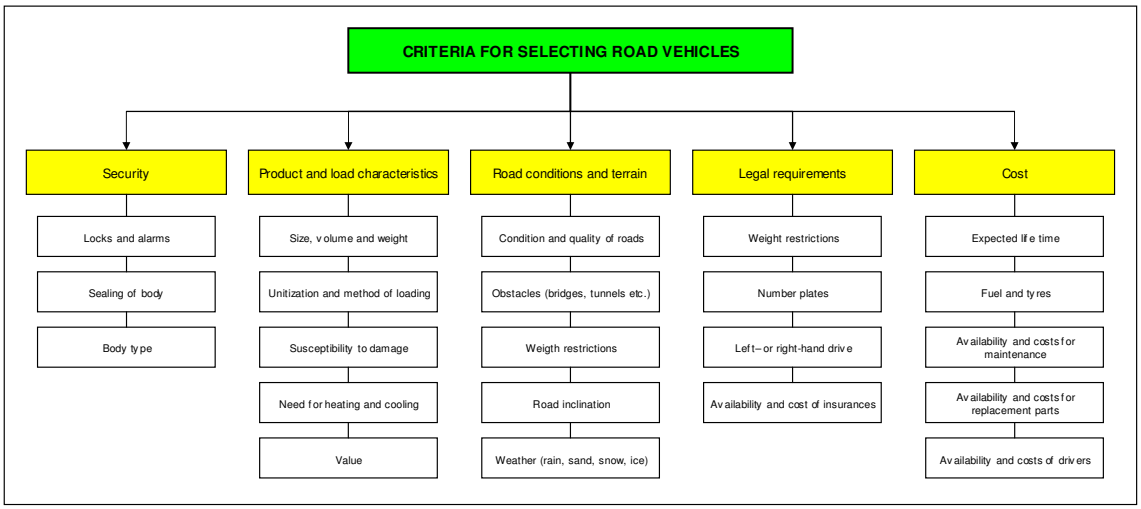

Figure 5.19 Criteria for selecting road vehicles

Safety of vehicles is of paramount importance as emergency services are unavailable in most places where humanitarian organizations work and it could take hours until victims are found and receive medical assistance. Accidents or breakdowns in a conflict area increase the time that staff, assets and goods are exposed to the conflict as well as to crimes.

Vehicle fleets should be standardized (UNHCR 2000, 255) in order to increase efficiency of operations, maintenance and management of replacement parts. Replacement parts, tyres, fuel, lubricants as well as the expertise for maintenance and repair must be available (UNHCR 2000, 265).

Vehicles must be suited for protecting consignments from exposure to sunlight, rain and snow, heat and cold as well as physical damage. Lorries must be furnished with effective heating and in hot climates with refrigeration unites or refrigerated containers to ensure maintaining room temperature for drug products throughout the entire transport. Vehicles must also be fitted with locks and alarms and allow sealing of the load.

Lorries should allow loading of pallets with hand pallet trucks over a bridge plate or with a tail-lift as well as with counterbalanced fork-lift trucks from the side or the rear.

The appropriate selection of the body type (van body or curtain-sided) is critical for protecting goods from the environment as well as from theft. The use of rigid shipping containers on flat bed vehicles provides good protection from the environment as well as theft.

Vehicles must be adapted to average travelling distances, the terrain, width and conditions of roads as well as obstacles such as low bridges or narrow tunnels. Vehicles must be easy to maintain and skilled mechanics as well as replacement parts must be available in the country of operations.

Especially when humanitarian organizations import their own vehicles, legal requirements such as size and weight limits, use of foreign number plates as well as the position of the steering wheel must be considered. Insurance with a national or, where unavailable, international agency which also covers war risks must be considered.

The whole life costs over the expected life time of vehicles operating under harsh conditions, including purchasing price, fuel and tyre consumption as well as costs of maintenance and repairs must be considered (Rushton, A., J. Oxley, and Ph. Croucher 2000, 400).

All means of surface transport must be furnished with communication equipment (UNHCR 2000, 252) for security reasons. The selected type and colour of vehicles should differ from those used by armed or security forces to avoid confusion and all vehicles should be clearly marked with stickers and flags which identify the humanitarian organization (Mayhew, B. 2004, 33). Special technical means such as lights, infrared illumination, transponder signals, radar, and underwater acoustic signals are necessary for aircraft and ships (Cauderay, G.C 1995).

The usefulness and appropriateness of using armour on vehicles is controversial. Armour can protect against rifle fire and blasts but will not protect passengers from the direct hit of a mine. Armoured vehicles are heavy and require special driving skills (Roberts, D.L. 2005, 126). If humanitarian organizations and their work are not accepted by the conflict parties, the effectiveness of humanitarian assistance is questionable. Moreover the resemblance to military vehicles can raise doubts concerning the neutrality towards conflict parties.

If humanitarian organizations should happen to have the choice between different commercial rail operators, apart from costs, safety and reliability of equipment should be considered.

In principle the same considerations apply to selection of boats for local transport. Apart from safety, flexibility, ease of operations as well as ease of maintenance should be considered.

Small aircraft must be able to operate without assistance of air traffic controllers and must be able to land on rough and improvised airstrips. Ships should be furnished with cranes which allow loading and unloading cargo without being dependent on port infrastructure.

5.5 Customer service plan

The overall customer service strategy must be translated into customer service policies which are tailored to humanitarian assistance programmes as well as the context within a country and consider the trade-off between service levels and costs.

Logistics managers need to develop customer service plans together with the managers of health care facilities as well as the responsible health programme managers in order to meet the service requirements of humanitarian assistance programmes.

The importance of individual customer service elements will depend on the type of assistance provided to health care facilities as well as the situation and context. During the emergency phase lead times must be as short as possible while longer lead times will be sufficient in the development phase. Maximum stock availability will be important if a health care facility is supported by a single humanitarian organization but not be critical where only occasional support is provided in addition to other sources. Moreover stock availability should be maximized for all items included in the programme standard list while all other items can be backordered to an upstream distribution centre or supplier.

Health programme managers will have to consider the trade-off between higher customer service levels and higher costs when determining the importance and targets for individual customer service elements. These then need to be continuously measured by logistics managers to ensure that the required level of service is maintained (Rushton, A., J. Oxley, and Ph. Croucher 2000, 43).

If several health care facilities are benefiting from a humanitarian assistance programme, health programme managers should determine the criteria for prioritization of customers in case of shortages of goods or transport capacities.

The fair share allocation (Bowersox, D.J., and D.J. Closs 1996, 289) ensures that all health care facilities receive some of the stock available at a distribution centre and avoids stockouts which could interrupt services. Available stocks are in principle allocated among all customers to raise their days of supply at all health care facilities to the same level.

The needs and priorities will depend on the type of programme and for example differ between a mass vaccination programme, emergency assistance to a hospital in a conflict area and rehabilitation of health care facilities after the acute conflict has ended.

A staff member needs to be identified to serve as a contact point for requests and inquiries from customers as well as for receiving orders. A system which allows contacting and collecting all necessary staff to provide goods and services after office hours needs to be established to allow reacting to urgent orders or emergency situations.

The range of goods which logistics services are required to keep in stock at all times need to be established and laid down in programme standard lists. Requirements for labelling and packing, which will also depend on national legislation and regulations, as well as documentation, need to be defined.

Customers need to be able to rely on a minimum remaining shelf life of all expendable goods in order to avoid expiry of goods at health care facilities as well as for considering parameters of inventory control systems at assisted health care facilities.

Logistics services need to guarantee maximum lead times for stock items to allow implementation and maintaining of a rational and systematic inventory control policy and delivery frequencies and schedules must be agreed upon.

Special transport needs such as distribution of cold chain items or dangerous goods must be provided. Logistics managers must define services which can be provided for installation, maintenance, service and repair of health care equipment as well as for training users and maintenance staff.

A customer service plan should also include data and information which logistics managers need to provide regularly to health programme managers for controlling their budgets as well as for donor reporting.

The customer service plan should be put in writing and be regularly reviewed and updated.

6 SUPPLY CHAIN OPERATIONS

This research focuses on strategic issues and commercial procedures for purchasing, warehouse operations and distribution in principle apply to operational logistics management in the context of humanitarian assistance. Moreover it is not possible to cover differences in the operational management in the many different contexts and situations in which humanitarian assistance is provided.

Therefore this chapter will discuss selected issues which are of particular importance for supply chain operations of health care goods in humanitarian assistance and of general relevance in this context.

The main objective of operational planning is to optimize the utilization of resources which are determined and allocated by the strategic and tactical framework which needs to be developed for every humanitarian organization and every humanitarian assistance programme (Thorn, J. 2002, 25).

6.1 Order placement

Orders for health care goods can be initiated by customers (pull) or can be initiated by others in anticipation of needs (push) (Chopra, S., and P. Meindl 2004, 8).

During the initial emergency phase where assistance is provided to a crisis area where the humanitarian organization has not been providing assistance to health care facilities before, humanitarian organizations will not have time to carry out an assessment (Perrin, P. 2002, 25). In situations where assistance is required immediately and no demand data or information on needs are available, health professionals at humanitarian organizations must select health care goods according to their experience and "push" them to the crisis area (Quick, J.D. (ed.) 1997, 323). As discussed in chapter 4, pre-packed kits rather than separate items will be used for the initial emergency response.

As soon as possible and for the remainder of humanitarian assistance programmes, needs should be assessed at health care facilities and health professionals in the field should place orders (Abdallah, S., and G. Burnham (ed.) 2000, 10-10) based on demand forecasts.

The type and quantity of ordered health care goods will be determined by health professionals at assisted health care facilities as well as by health programme managers, among others, according to needs, the level of provided health care services as well as staff skills. The programme standard list should cover the majority of health care goods which are regularly used. However the selection of goods for individual health care facilities should also consider some implications for logistics management.

Where applicable, ordered goods must be compatible with other devices and existing equipment which health care facilities might be receiving at the same time from different sources. The use of disposable goods reduces the required capacity for sterilization but increases the need for resources for regularly replenishing and storing goods.

Order quantities should be calculated systematically and according to a clearly defined inventory control policy in order to minimize the problems of subsequent demand distortion in the upstream supply network. Overstocking will require returning and safely disposing of health care goods which have expired before they can be used while shortages will lead to urgent orders which require expensive expediting.

All orders for drug products should indicate commonly used and understood international nonproprietary names rather than proprietary names which are specific to each manufacturer (PAHO 1983, 71). Before ordering cold chain items the feasibility and ease of delivering them to health care facilities should be considered (PAHO 1983, 72).

For orders of health care equipment availability of after-sales services by qualified technicians as well as service and replacement parts must be considered (Cheng, M. 2003, 7). Moreover the availability of required energy sources such as electricity, gas or kerosene must be considered. Where reliable energy sources are not available providing generator sets or delivering appropriate fuel will be necessary.

Since, at least during the emergency phase, humanitarian organizations will provide health care goods according to their own standards, health care facilities may have to substitute health care goods they were commonly using before being assisted. However the respective programme standard list should cover all essential needs.

Prepared and approved orders should be transmitted to logistics services as quickly as possible, wherever possible electronically.

6.2 Purchasing transactions

Goods are ordered from suppliers which have been selected according to the strategic framework as well as the tendering process. The primary concern of logistics managers must be to ensure that all purchased goods comply with the required quality standards. If they cannot be met, orders should be sent upstream to be filled by the regional or international distribution centre.

Except for direct purchasing, a detailed written contract including trade terms should be concluded for every purchase (Kaur, M. et al. 2005, 136), signed by both parties to the contract and carefully filed for donor reporting and possible auditing.

Apart from the specifications of ordered goods and their quantities, purchasing contracts should include details on the required quality standards (Kaur, M. et al. 2005, 160). For drug products the pharmacopoeial standard, the requirement to provide the manufacturer's certificate of analysis (WHO 2002a, 4) for each batch of drug product as well as the minimum remaining shelf life upon delivery should be stated. All packages must be marked with the required storage conditions.

Packing quantities and the language of labelling and documentation such as package inserts should be indicated. For health care equipment the warranty period as well as required documents such as operating instructions or service manuals should be stated (Kaur, M. et al. 2005, 184). If distribution to health care facilities is undertaken with transport means of low capacity, maximum sizes and weights of packages should be specified.

Purchasing contracts should clearly specify maximum lead times or delivery dates and possibly include penalties for late deliveries (Kaur, M. et al. 2005, 184), although these may be difficult to enforce.

After receipt of goods from suppliers, detailed inspections must be carried out (WHO 1999c, 17), ideally by qualified pharmacists who ensure their compliance with the required quality standards as well as with samples provided during the tendering process. Suppliers must also ensure quality and prevent deterioration during transport to the receiving store.

Price and currency, terms of payment as well as the terms of trade should also be clearly indicated in the purchasing contract (Kaur, M. et al. 2005, 154). Advance

payment to supplier should be avoided as payments may be difficult to retrieve in case delivered goods do not comply with the purchasing contract.

For each purchasing transaction, logistics managers should measure and record supplier performance (Kaur, M. et al. 2005, 117) such as quality of delivered goods and lead time which will serve as selection criteria for future purchases.

6.3 Storage

Within the strategic and tactical framework, supply chain operations are essential to ensure availability of goods, provide high service levels as well as to maintain the high quality of goods and prevent deterioration during storage and handling.

In many countries employment of a qualified and licensed pharmacist will be the precondition for humanitarian organizations to receive permission for establishing and maintaining stores for health care goods.

6.3.1 Stock replenishment

At regular intervals which are defined by the inventory control policy or whenever the inventory position drops to the respective hastening level, replenishment orders are calculated at every store for all items included in programme standard list.

Accurate and complete end-user demand data, usually as written reports, needs to be collected from all assisted health care facilities regularly, entered into the information system and aggregated over the review period. Moreover data from health information systems is needed for all items for which the morbidity method is applied.

Received data needs to be reviewed and corrected for errors as well as for stock issues due to expiry or damage of goods in the respective pharmacies.

With the final set of data a forecast is made using time series analysis with moving averages or by applying the morbidity method. The results of the forecast need to be carefully reviewed item by item and may have to be corrected by qualitative forecasting methods. Judgment is required to adjust forecasts for expected increases in demand due to increased or decreased conflict intensity, seasonal changes of morbidity patterns as well as expected increases or decreases of assistance to the same health care facilities by other sources.

Data collection is completed by carrying out a complete physical stock count as well as calculating backorders and stock on order for each stock item.

The selected inventory control policy is applied to calculate the required quantities, which may have to be rounded to the respective packing quantities.

6.3.2 Preventing deterioration

One of the primary concerns of logistics and supply chain management is to ensure that the high quality of purchased health care goods is maintained (Bowersox, D.J., and D.J. Closs 1996, 415) throughout the flow through supply networks up to the end-user. Appropriate handling and storage at warehouses is an important part of overall quality assurance measures (Dörner, G. (ed.) 1992, 26) especially in countries with unfavourable climatic conditions such as high temperatures and humidity (Dörner, G. (ed.) 1992, 17).

With the exception of emergencies, for all health care goods with expiry dates the first-expiry/first-out (FEFO) rule, where batches with the shortest remaining shelf life

are picked first, must be strictly applied (Quick, J.D. (ed.) 1997, 369). Therefore even if a consignment of goods which is requested by a customer arrives at the warehouse, it must be put-away and the batch with the shortest remaining shelf life picked instead. The need for stock rotation therefore limits cross-docking to stockless depots or emergencies where time for put-away and ordering picking is not available.

Strict stock rotation maximizes the overall remaining shelf life of health care goods provided to end-users. However stock rotation also minimizes waste from health care goods expiring in stock which could not be justified towards donors. Moreover disposal of drug products are subject to strict procedures in many countries and require reporting and destruction under the supervision of the respective health authorities. Humanitarian organizations then have to justify destruction of drug products in a country with chronic shortages of health care goods.

A regular turnover of stocks must also be ensured by regularly reviewing stock levels and avoiding overstocking (Jessop, D., and A. Morrison 1994, 228) which inevitably will increase the likelihood of goods expiring in stock.

For all health care goods without expiry dates, such as some types of non-sterile dressing material or reusable goods, the first-in/first-out (FIFO) principle should be applied where goods are picked in the same order as they have been received (WHO 1998, 9). Even goods without expiry dates will eventually deteriorate and stocks should therefore be turned over regularly (Jessop, D., and A. Morrison 1994, 212).

A further concern is the protection of stocks from adverse influences and damage.

Stocks of health care goods, which are often packed with plastic materials and cardboard, need to be protected from inflammable goods by constructive measures. Laboratory reagents and fuel need to be stored in a separate store, ideally a separate building (Dörner, G. (ed.) 1992, 25). Further measures to reduce the risk and consequences of fires are keeping stores clean, storing packing material separately, as well as installing smoke detectors and fire fighting equipment (Mayhew, B. 2004, 78).

Warehouse staff needs to be made aware of the importance of carefully handling goods and avoid damage to packing, packaging as well as the goods themselves by dropping, throwing or crushing during manual or mechanical handling. Limiting the weight of parcels as well as providing adequate and sufficient materials handling equipment for unloading, internal movement and loading will facilitate their careful handling.

Stocks must be protected from damage and contamination by insects, rodents and birds (UNHCR 2000, 259) by maintaining buildings and closing any gaps or cracks as well as covering ventilation openings with grills and nets and taking active measures for pest control.

Goods need to be protected from dust and sand by covering openings and storing goods in closed packages. Protection from sunlight can be achieved by choosing windowless stores, closing openings in the store or covering them with shades as well as by storing goods in their original packaging and packing (PAHO 2001, 152).

The use of ventilation, air conditioners or dehumidifiers will reduce the risk of damage through humidity. Damage through rainwater, one of the greatest dangers to goods, can be avoided by selecting adequate storage facilities and careful maintenance, especially of the roof. In order to avoid damage through rain water leaking into the building or by flooding from the outside, all goods must be stored off the floor on shelves or floor pallets.

Too high as well as too low temperatures are frequent and serious dangers for health care goods, especially drug products. Health care goods, and especially drug products, must be stored within the temperature range indicated on the packaging, at room temperature, cool or refrigerated (PAHO 2001, 152). Depending on the prevailing climate, maintaining appropriate storage temperatures will require air conditioning or heating. However goods must not be stored too near to heaters or pipes to avoid too high temperatures in heated stores. The temperature of store rooms must be measured and recorded twice a day.

Some drug products, diagnostic agents and especially vaccines require permanent refrigeration between 2-8° Celsius. Apart from reliable refrigerators or cold rooms, a reliable and permanent power supply and backup must be available.

6.3.3 Warehouse operations

The main functions warehouses and stores perform are receipt and inspection, put-away, storage, order picking, packing and marking, consolidation as well as loading and shipping of goods (Lambert, R.S., and J.R. Stock 1993, 276). Moreover records of movement as well as stock levels of all goods must be maintained.

Assets and stocks at warehouses must be protected by physical and technical means as well as unarmed guards from theft as far as possible (Bickley, S. 2003, 53). Most humanitarian organizations do not use armed security guards as they may actually increase insecurity (Bickley, S. 2003, 54).

Immediately after receiving and unloading consignments, goods requiring special storage conditions, such as cold chain items or drug products subject to international control, should be separated (PAHO 1983, 72) and processed first. Moreover goods which are backordered by customers should be identified and prepared for packing immediately.

In order to avoid double-handling, batches of goods which will be stored on floor pallets should be separated and carefully stacked onto floor pallets during unloading.

Upon receipt the quantity and specifications of delivered goods must be compared against purchase contracts, shipping documents and the condition of packing and goods must be checked for possible damage during transport (Lambert, R.S., and J.R. Stock 1993, 275).

All health care goods arriving from a supplier and entering the internal supply chain of the humanitarian organization must be carefully inspected by a qualified pharmacist. Samples of received goods are compared with samples received during the tendering process and specifications of received goods are compared with supplier documents as well as the goods themselves.

Goods which do not comply with the required specifications need to be stored in quarantine until return to the supplier to ensure that they are not accidentally picked, packed and shipped.

Goods which are kept in transit for later export and are exempted from duties and taxes must be stored separately in a bonded warehouse or store (Bowersox, D.J., and D.J. Closs 1996, 400). National legislation must also be considered for storage of narcotic drugs and psychotropic substances which must be kept locked in a safe or even a separate safe room (Dörner, G. (ed.) 1992, 40).

Goods of similar characteristics are assigned to different warehouse zones for dangerous goods, cold storage or secure storage (Dörner, G. (ed.) 1992, 43) as well as to different zones according to the required storage equipment.

Within the zones health care goods are stored according to their categories and within in alphabetical order of their international nonproprietary names (Dörner, G. (ed.) 1992, 18). Several batches of the same item must be stored separately according to their expiry dates (PAHO 2001, 151). Especially for drug products, this system allows any storekeeper to locate an item quickly without having to know their pharmaceutical classification or therapeutic group.

To ensure stock rotation and comply with the FEFO and FIFO principles, order picking must be carried out according to a picking list generated by the information system. Otherwise store keepers will be tempted to pick the batch which is most convenient for them. Original supplier packaging of drug products must not be opened as repackaging of drug products requires a license and must be carried out by a qualified pharmacist.

According to the World Health Organization all goods should have a remaining shelf life of at least one year upon arrival in the country receiving humanitarian assistance (WHO 1999a, 8). Even if these guidelines are followed, the remaining shelf life will be reduced by storage at each tier of the supply network within the country. However distribution of health care goods is permissible according to the World Health organization, provided that health professionals are aware of the short remaining shelf life and can make use of health care goods before expiry.

Depending on stock levels and expected demand at each health care facility, logistics managers must ensure that health care goods with sufficient remaining shelf life are provided. Expired goods must never be distributed (PAHO 2001, 153). Delivery of health care goods to health care facilities shortly before expiry must also be avoided as they are likely to be used even after expiring, especially if there is a shortage of these items.

The three main functions of packing are to increase handling efficiency, protect goods from damage and identify goods (Bowersox, D.J., and D.J. Closs 1996, 436). Health care goods require protection from environmental conditions such as humidity, water and sunlight, insects and rodents, mechanical damage, dirtying and foreign matter as well as pilfering.

The packing material should be adjusted to the susceptibility of the packaged goods to damage as well as their value (Bowersox, D.J., and D.J. Closs 1996, 439). The use of corrugated cardboard boxes allows packing health care goods effectively, quickly and at low cost. Dunnage provides additional protection to goods and increases the overall strength of packing. Health care equipment might require special packing (Heimann, P., A. Issakov, S.Y. Kwankam (ed.) 2000, 21) for example in wooden crates. Cold chain goods must be packed in specially designed and certified cold boxes and the temperature inside insulating packaging should be recorded with temperature monitoring devices (WHO 2005, 1).

Drug products should be packed separately (PAHO 2001, 150) as most of them require special transport and storage conditions. In order to allow for and facilitate manual handling, the total weight of each parcel should not exceed 25 kilograms (PAHO 1983, 67). If pack-animals are used for transport the size and maximum weight of packages need to be adjusted and each package must provide protection from sun, dust and rain.

Marking and labelling is essential to identify packages, indicate related shipping documents such as packing lists, indicate consignee and destination, provide handling and storage instructions as well as safety instructions for dangerous goods. The markings of kits should indicate their contents as well as the expiry dates of all contained items.

Depending on the transport route and destination, packages might have to be marked in several different languages. Cold boxes must be clearly marked to ensure their preferential treatment at airports or other transhipment points and ensure adequate intermediate storage.

If several vehicles or aircraft are loaded at the same time, the ratio of their weight and volume must be considered (Rushton, A., J. Oxley, and Ph. Croucher 2000, 92). Packages of high and low density must be mixed in order to avoid a fully loaded vehicle not utilizing its maximum load while loading of another vehicle half way with high density goods is limited by the maximum weight.

Efficiency of handling of consignments can be increased significantly by unitization of packages and master cartons on pallets. Stretch-wrapping increases the stability of unit loads and provides additional protection, especially against dust and rain without adding significant weight and at low cost. Finally pallets or loose packages are loaded on vehicles for shipment. If loose packages are loaded, great care must be taken that packages are carefully stacked and packages at the bottom are not damaged or crushed by loads stacked upon them. Damage can be limited by tightly loading vehicles and securing goods with straps in order to prevent shifting during transport (Bowersox, D.J., and D.J. Closs 1996, 440).

Each consignment must be accompanied with detailed shipping documents. In order to avoid delays at customs and comply with national pharmaceutical regulations, packing lists must indicate, among others, the details of all health care goods such as manufacturer, country of origin, batch number and expiry date.

6.4 Distribution to customers

If several modes of transport are available for a specific shipping leg, the most suitable mode of transport must be determined according to the criteria discussed in chapter 5.4.2. However the final distribution will be carried out by road transport in most cases.

The most important requirements for transport services are reliability and consistency as well as flexibility (Lambert, R.S., and J.R. Stock 1993, 165).

6.4.1 Routing and scheduling

Routing and scheduling is the most important operational transport decision (Chopra, S., and P. Meindl 2004, 436).

As the primary concern of logistics managers is the security of staff, assets and goods, the trade-off between delivery frequency and risk must be considered.

Vehicles are easily identifiable targets and nearly half of all security incidents occur during travel (Bickley, S. 2003, 60). The "economies of risk" requires using larger vehicles, consolidating consignments into full car or truck loads and reducing delivery frequency and flexibility if necessary. For the driver and the assets, the risk of travelling through a dangerous area is the same whether the vehicle is empty or full. Consequently two deliveries with a half full vehicle will double the risk for the driver. Likewise two deliveries of full car loads incur twice the risk of a single delivery with a truck which can carry the same load as two cars.

The majority of injuries and fatalities of humanitarian workers are caused by traffic and vehicle related accidents (Bickley, S. 2003, 60) rather than by conflict related risks. In order to maximize safety for drivers and vehicles, vehicles must be well maintained and in good condition (Bickley, S. 2003, 63). However breakdowns of vehicles also

pose significant security risks as vehicles which have to stop are easier to target and the lengthening of the journey also increases the overall security risk especially if safe places cannot be reached before dark. Among alternatives the safest route should be selected to minimize the risk of road accidents.

Every vehicle travelling along a dangerous route must be accompanied by at least another vehicle (Bickley, S. 2003, 69). Drivers can assist each other in case of accidents or security incidents, and all staff can continue their journey in case a broken down vehicle has to be left behind. Drivers must be familiar with the area and road network in order to avoid unintentionally deviating into more insecure areas and losing their way. Local drivers are familiar with road conditions and impassable sections as well as more knowledgeable about mined areas and roads and other potential threats (Bickley, S. 2003, 64). Roads used by the local population and commercial transport can be considered as safer as deserted roads.

Vehicles and convoys should not drive at night (PAHO 2001, 122) and if journeys last more than one day, safe places must be planned along the route for drivers to spend the night.

Before every journey, approval must be obtained from all concerned authorities as well as conflict parties (Roberts, D.L. 2005, 90), especially when check points and front lines have to be crossed (Mayhew, B. 2004, 36). When national borders or borders between areas with different ethnicity, religious or cultural beliefs or political convictions are crossed, drivers must be carefully selected in order to avoid putting them at risk (PAHO 2001, 123). In case of doubt "neutral" staff from countries considered as impartial must be employed.

If permissions are not granted, alternative routes must be used or transport must be postponed until further negotiations are successful. Warnings on dangers along routes given by authorities or conflict parties, which may be genuine or simply an attempt to obstruct humanitarian assistance, must be followed in any case (Roberts, D.L. 2005, 95).

In order to avoid mined roads and sniper areas, as much information on the security situation along the planned route should be gathered from local staff members, local authorities, security forces and other humanitarian organizations (Roberts, D.L. 2005, 45). All staff must be briefed on the security situation and security measures before departure (Mayhew, B. 2004, 16).

Since armed or security forces are likely to come under attack from the air or the ground, vehicles of humanitarian organizations should keep their distance (Roberts, D.L. 2005, 66). There is general agreement that the use of armed escorts should be avoided since they tarnish the image of humanitarian organizations, pose problems of liability in case the use of force results in harm and may increase vulnerability to attacks (ECHO 2004, 74). However some humanitarian organizations resort to the use of armed forces in some contexts or may be obliged by the authorities.

Transport resources may be planned and positioned to meet security needs, facilitate transport of staff or according to the needs of the largest humanitarian assistance programmes, often distribution of food and household goods. Even though these resources may not be positioned ideally for supplying health care facilities assisted by the same humanitarian organization, using established physical distribution networks may nevertheless be more efficient than establishing parallel systems to optimize distribution of health care goods.

Before any further planning, national legislation and transport regulations (Lambert, R.S., and J.R. Stock 1993, 15) such as safety regulations, maximum vehicle loads or maximum daily driving hours need to be considered.

The trade-off between transport economies as well as transport frequency and responsiveness is a key consideration for transport planning (Chopra, S., and P. Meindl 2004, 451). Consolidation of consignments into single shipments increases vehicle utilization and decreases transport costs. However, especially when order volumes are small, transport consolidation results in less frequent deliveries which in turn increases demand distortion (Thonemann, U., K. Behrenbeck, R. Diederichs et al. 2003, 118) and requires the increase of stock levels. Infrequent deliveries also decrease the ability to respond quickly to changes in demand or deliver urgently required health care goods.

Transport efficiency as well as transport frequency can be increased by consolidation of health care goods with other humanitarian assistance goods such as food or shelter material, requested by the same destination. Another possibility is consolidation of health care goods from different humanitarian organizations but for the same destination into one shipment. Commercial carriers, provided they are available, can consolidate consignments from several customers in a single shipment and improve efficiency.

Overall transport planning should be flexible (Chopra, S., and P. Meindl 2004, 452) and allow to be changed quickly in case the delivery of a routine consignment becomes urgent and requires expediting. This might require changing the planned mode of transport or cancelling planned transportation to one customer in order to serve another customer first. Transport planning should also allow the flexibility of serving a customer from another distribution centre in case the intended source faces a stockout (Bowersox, D.J., and D.J. Closs 1996, 485). Alternative transportation routes should be planned for in case the original route is impassable or no longer considered safe enough (Ockwell, R. A. 1994, 118).

Another means of filling urgent orders is diverting and re-consigning shipments which are already en route to another customer (Bowersox, D.J., and D.J. Closs 1996, 313). Even though transport needs to be planned in advance, it must also remain flexible to allow considering unexpected changes of customer orders.

Some degree of redundancy should be included in the overall transport planning so that transport schedules do not have to be disrupted in case unexpected customer demands need to be filled urgently.

Among available alternatives, first of all the safest and most reliable route must be selected (PAHO 2001, 124) even if it is much longer and adds several days to the journey. For long journeys availability of services such as fuel stations and workshops must be consider along the entire route. Routines should be avoided and where possible alternative routes chosen at random (Bickley, S. 2003, 67).

When calculating travelling time, some reserve time should be planned to allow for delays (Bickley, S. 2003, 67) and contingencies such as vehicle breakdowns, unplanned detours and longer than expected waiting times at borders or checkpoints.

In order to avoid pilfering and diversion, wherever possible consignments should be delivered directly to the pharmacy of the assisted health care facility and handed over personally to the person in charge rather than delivering to intermediaries who forward consignments to the recipients.

Routing of aircraft requires specialists as a multitude of factors such as type of aircraft, altitude of the destination, condition and length of runways and airstrips,

availability of fuel at the destination, weather conditions as well as national and international regulations have to be considered (PAHO 2001, 125).

Accountability of humanitarian organizations towards recipients as well as donors implies that all shipments of health care goods must be accurately tracked and accounted for.

6.4.2 Protection of goods

During transport goods need to be protected from damage, deterioration as well as theft (Steinbuch, P.A. 2001, 276). Damage of goods not only incurs cost for their replacement but also costs for urgent purchases and expediting of critical goods (Steinbuch, P.A. 2001, 285).

During transport loads will be subject to vibration and shocks and goods need to be protected during transport by careful packing, securing loads in vehicles, avoiding roads which are in poor condition and careful driving. Before departure vehicles must also be checked for any leaks in the body of vehicles to prevent damage of consignments from rain, snow and direct sunlight.

Cold chain goods are particularly susceptible to damage and require guarding against deviation of the required temperature even during a very short period of time. For large consignments refrigerating containers or refrigeration devices which are installed in the vehicle can be used. The advantage of unlimited transport time has to be balanced against the fairly high cost of devices as well as the risk of breakdowns and the need for maintenance (Laurent, E., and H. Everts N.d., 33).

Most commonly specially designed insulated cold boxes in which cold chain goods are surrounded by frozen ice packs are used which maintain the required temperatures for several days even in a tropical environment. This method is reliable, fairly cheap, can be used on any means of transport and does not rely on any power supply during transport.

In order to avoid unnecessary long exposure of drug products, especially cold chain items, to high temperatures during interim storage, wherever possible consignments should be customs cleared at the destination port before shipment (Ockwell, R. 1994, 148). Documents are submitted to the respective drug regulatory as well as customs authorities in advance and shipment is only requested once all necessary permits have been obtained. In order to avoid storage in the open and exposure to sun and rain, reliable clearing agents should be contracted or consignments picked up at ports immediately upon arrival from dedicated staff employed by the humanitarian organization.

Several international conventions intend to simplify and speed up customs procedures for clearance of humanitarian assistance consignments. However they apply only in countries which have acceded and enacted national laws. The "Recommendation of the Customs Cooperation Council to expedite the forwarding of relief consignments in the event of disasters" (CCC Recommendation, 1970) aims at facilitating the crossing of frontiers. The "International Convention on the simplification and harmonization of Customs procedures" (Kyoto Convention, 1973) includes an annex on relief consignments, which exempts humanitarian organizations from duties and taxes for imported humanitarian assistance goods and requests customs authorities to give them priority in carrying out customs controls and formalities. The "Customs Convention on the A.T.A. carnet for the temporary admission of goods" (A.T.A. Convention, 1961) allows using the same documents for several border crossings. Annex B 9 of the "Convention On Temporary Admission" (Istanbul

Convention, 1990) simplifies and harmonizes procedures for the temporary importation of goods such as vehicles, telecommunication equipment or health care equipment which are used for the provision of humanitarian assistance.

The risk of theft and pilfering can be reduced by using vehicles with rigid bodies, sealing vehicles immediately after loading and employing trustworthy staff.

All transported goods should be insured against damage as well as theft during transport.

6.4.3 Reverse logistics

Although health care goods will predominantly flow downstream to end-users, the distribution system must also support reverse logistics processes (Rushton, A., J. Oxley, and Ph. Croucher 2000, 102).

Redundant stocks of health care goods which have accumulated because of large forecasting errors, errors in calculating replenishment orders, unexpected decreases in demand or because assistance to health care facilities has been decreased unexpectedly (Jessop, D., and A. Morrison 1994, 236) and which are in danger of expiry need to be redistributed. They can either be distributed to other nearby health care facilities or returned to the national distribution centre for distribution in other parts of the country. Items may also be returned to upstream stores because of defects, wrong deliveries or overstocking (Lambert, R.S., and J.R. Stock 1993, 18).

An efficient system for returning health care equipment to national distribution centres, domestic or international suppliers must be established in case repairs or servicing cannot be carried out at the health care facility or domestically.

In case of product recalls a system must be in place to quickly identify all health care facilities which have received the faulty batch of drug products or other health care goods, inform them immediately and retrieve all remaining stocks (WHO 1992c, 28).

Returning recalled products to the distribution centre and placing them in quarantine ensures that health care products are not used or sold against the manufacturer's advice. Recalled health care goods are then either returned to the supplier for exchange or disposed of safely.

Damaged and expired health care goods may have to be returned to an upstream distribution centre if facilities for their disposal or not available locally. Expired drug products are one category of waste controlled under the Basel convention (1989) which prohibits export to another country and which must therefore be disposed of appropriately in the country from where it originates.

In order to avoid abuse, resale of expired health care goods as well as original supplier packaging and damage to the environment, disposal must follow guidelines issued by the World Health Organization. High temperature incineration, inertization and waste encapsulation are suitable methods for disposal of drug products (WHO 1999b, 16).

In any case humanitarian organizations must comply with national legislation and regulations which may require notifying the Ministry of Health and destruction under the supervision of the authorities.

6.5 Customer service

Even though for different reasons, orders and the order fulfilment process being at the heart of commercial organizations (Christopher, M. 1998, 226) applies to

humanitarian organizations too. The customer order cycle consists of order receipt, order entry, order fulfilment and order receiving (Chopra, S., and P. Meindl 2004, 9).

The overall objective is to deliver complete and correct orders to customers within the promised lead times at the overall lowest cost (Chopra, S., and P. Meindl 2004, 11).

6.5.1 Order processing

All customer orders should be received and processed by dedicated customer service staff. Any received customer orders must be carefully recorded for future reference and should be treated immediately in order to decrease overall lead time.

After review for completeness and consistency, customer orders are entered into the information system, ideally by uploading electronic files. If orders are received in writing or transmitted by voice, the accuracy of order entry is crucial to avoid mistakes which will entail urgent customer orders when the mistake is noticed by the customer during delivery.

Customers must receive a written order acknowledgment which confirms receipt and entry of each customer order as well as information on stock availability and expected delivery date. For any items which are out of stock, customers must be offered available substitutes or orders for the respective items forwarded upstream for immediate and urgent processing.

Customer orders for emergency situations as well as urgent orders because of stockouts at assisted health care facilities must be treated as a priority while the remaining orders are processed according to the first-come-first-serve policy.

Customer orders must be filled accurately and according to the promises of the customer service plan. Despite the pressure to deliver quickly, order fulfillment must be especially accurate with emergency orders since mistakes will have grave consequences and immediately lead to more urgent orders.

Any items which are not kept in stock or have stocked out, must be recorded in a detailed backorder record. Customers must be regularly updated on backorders and their status for further planning and comparison with their own records.

All parcels must be clearly labelled with the customer, destination as well as the order reference number and must be accompanied by detailed packing lists and if necessary customs documents.

Customers must be informed of expected dates of deliveries, mode of transport, contents as well as overall weight and volume of shipments in advance (PAHO 1983, 74) so they can prepare staff and pharmacies for receipt.

Upon receipt of consignments, customers must check the contents against shipment documents and an authorized person at the receiving health care facility must confirm completeness of deliveries and indicate any short shipping. Customer orders, or the respective line items, are only to be closed once written confirmation of their receipt is available from the customer. Auditable confirmations are also indispensable for humanitarian organizations to prove actual distribution of humanitarian assistance goods to the respective donors.

6.5.2 Customer service measurement

Customer satisfaction, being the ultimate goal of any supply chain, needs to be measured and evaluated regularly (Govil, M., and J.M. Proth 2002, 90).

The customer service elements mentioned in chapter 4.5.2 need to be measured and monitored regularly by analysing data from information systems as well as by carrying out customer satisfaction surveys using interviews or questionnaires.

Comparison of achieved levels of service with the levels laid down in customer service plans allows to identify service elements which require improvement as well as to benchmark against performance of other humanitarian organizations.

7 CONCLUSION

7.1 Summary

Despite the perception that the number and extent of armed conflicts is decreasing, the research outline shows that millions of affected people are in need of humanitarian assistance every year.

For narrowing down the research topic as well as for the state of the field, academic logistics and supply chain literature as well as publications issued by humanitarian organizations are considered.

In order to answer the main question of how humanitarian organizations can manage the supply chain for health care goods in complex political emergencies, the research is placed in the context Thorn's hierarchical planning framework.

The analysis of humanitarian assistance identifies and structures a multitude of objectives towards different groups which are relevant for logistics and supply chain management. A number of constraints related to humanitarian organizations, the context of less developed countries as well as complex political emergencies are identified. Health care goods are classified in different categories and some characteristics with relevance to their logistical management are elaborated upon. The susceptibility of many health care goods to deterioration and damage points to the paramount importance of quality assurance throughout the supply network.

From the analysis of humanitarian assistance, a proposal for ten logistics and supply chain management objectives is derived. Minimizing safety and security risks is identified as one of the priorities which strongly influence all aspects of logistics and supply chain management. Similarly, the problem of low quality health care goods and the imperative of providing recipients with high quality health care goods are critical and have far reaching implications for humanitarian organizations. The need for simplification and reduction of complexity is identified and the implications for the need of independence as well as accountability of humanitarian organizations are analysed.

The ten logistics and supply chain management objectives are then summarized into cost (resources), risk (insecurity) and reduction of suffering (customer service). These three groups of objectives are related inversely and allow determining the effect of favouring any of the objectives.

Based on Thorn's framework, supply network design, supply chain planning and supply chain operations are determined as the strategic, tactical and operational management level respectively. At each management level specific issues are identified within the second dimension of logistics processes, namely item selection, sourcing, storage, transport and customer service.

Finally Thorn's framework is extended by considering the three aspects of time, distance and criticality. The time aspect considers the emergency, rehabilitation and reconstruction as well as the development phase. The distance to the crisis area is related to the level of safety and security risks and, in most cases, to the level of development of countries. Finally, the third aspect considers the criticality of individual items.

The resulting framework is the basis for developing strategies at each management level, for each of the logistics activities and for different stages within the aspects of time, distance and criticality.

The item selection strategy introduces the kit concept which is particularly useful during the emergency phase and considers the importance of standardization and variety reduction.

Quality assurance and its substitution are identified as the main determinant for developing a framework for choosing between purchasing centrally or decentrally. The sourcing strategy further considers pre- and post-qualification of suppliers, trade-offs between dual and multiple sourcing as well as the width of the supplier base.

A strategy for developing a facility network heuristically is proposed which extends the smallest possible core of a supply network step by step by considering the logistics and supply chain management objectives as well as the context and constraints of humanitarian assistance. A centralized facility network with one storage facility in the country with direct distribution to customers is proposed.

Some strategic criteria for site and facility selection as well as ownership of storage facilities are discussed. A strategic contingency plan which considers emergency stocks at all tiers of the supply network is developed and three distinct phases of emergency preparedness, emergency intervention and emergency response are proposed. The facility network design strategy is complemented by determining criteria for the number of tiers in and the complexity of the supply network as well as the trade-off between the objectives of effectiveness and efficiency.

The physical distribution strategy determines criteria for selecting different physical distribution channels and discusses a contingency plan for transportation. Strategic criteria for selecting modes of transport as well as the ownership of transport means are discussed in detail. The framework for physical distribution is completed by considering the trade-off between effectiveness and efficiency.

The customer service strategy applies concepts and principles from commercial logistics and supply chain management to recipients as well as programme managers and considers relevant customer service elements. The advantages and importance of collaborative planning are discussed. The customer service framework is completed by considering the scope of services and service levels in relation to the aspects of time, distance and criticality.

Finally a simple strategic framework for selection of communication and information systems is developed which considers dependency, complexity, efficiency, the level of integration and the use of electronic versus manual records.

The five logistics activities are also analysed at the tactical level of supply chain planning.

The concept of Essential Drug Lists, one of the corner stones of the Primary Health Care concept, is extended to other health care goods for developing the concept of programme standard lists and the advantages and disadvantages of using kits are discussed.

The advantages and disadvantages of pre- and post-qualification of suppliers, criteria for supplier selection as well as different possibilities of purchasing contracts are discussed and a framework based on importance of quality as well as annual purchasing value is developed.

The analysis of inventory control systems introduces the notion of multi-echelon systems and the problems caused by demand distortion into humanitarian supply chain management. The importance of collecting end-user demand data and using global information throughout the supply network for demand forecasting is stressed.

A hierarchy for forecasting from the macro to the micro level as well as a framework for choosing between time series analysis, the morbidity method and historical analogy is proposed. The imprest system is proposed for inventory control at the level of health care facilities while a (R, S) system is proposed for stores managed by humanitarian organizations. Finally a periodic review (S-1, S) system is proposed for replenishment of emergency stocks.

A framework for deciding on stock positioning of items at all tiers of the supply network is proposed. For the positioning of contingency stocks throughout the supply network a dynamic strategy for shifting emergency stocks downstream according to three distinct phases which allows increasing responsiveness while limiting necessary echelon stocks is developed.

Within existing supply networks the options of direct shipment, transhipment, cross-docking as well as lateral transhipment are discussed. Criteria for selecting a suitable mode of transport are discussed in detail. The use of different supply channels and possibly modes of transport for expediting deliveries in case of impending stockouts is suggested in order to reduce safety stocks while maintaining the required service level. A framework for partially outsourcing transport capacities is proposed and some criteria for selecting means of transport are discussed.

Finally the development of customer service plans which are tailored to the needs of individual humanitarian assistance programmes is suggested.

The final chapter discusses some issues relevant for health care goods at the level of supply chain operations. The use of a "push" system during the initial emergency phase and the transition to a "pull" system is proposed and some operational issues concerning purchasing transactions are discussed.

Some important issues for handling and storage of health care goods as well as protection of goods during transport, especially for cold chain items and the need to maintain the quality of goods throughout the supply network are discussed.

The importance of considering the safety and security of staff for routing and scheduling as well as the need for flexibility and considering alternative routes are discussed.

Finally the concept of measuring and monitoring customer service in humanitarian supply networks is introduced.

While the thesis does not present a complete solution which suits any organization in any situation, the presented framework allows addressing all issues of logistics and supply chain of a particular humanitarian organization in the context of a particular complex political emergency with all its constraints.

The development of the framework shows that existing logistics and supply chain management concepts can be applied or adapted to the context of humanitarian assistance. The existing body of knowledge on logistics and supply chain management in disasters and in developing countries is extended to humanitarian assistance in the context of complex political emergencies.

While the research does not claim to have developed new logistics and supply chain management concepts, its value lies in systematically structuring the issues relevant for logistics and supply chain management in humanitarian assistance and applying relevant commercial concepts.

The structured and systematic approach offers comprehensive and practical solutions to all aspects of logistics and supply chain management of health care goods which is nevertheless well founded in theory.

7.2 Critic

Although the research is based on an extensive and detailed review of relevant literature, the quality and scope of available literature proved to vary significantly between topics. For example almost no literature is available on inventory control in the context of humanitarian assistance while extensive literature is available on security or transport.

The research is based on premises concerning the objectives, context and constraints of humanitarian assistance which are derived from literature analysis. In order to ensure that the framework is generally valid, its development is based on heuristics, analogy and reasoning rather than on case studies.

However in order to demonstrate the practical value of the framework, it needs to be applied to actual complex political emergencies.

The proposed inventory control policy needs to be applied to a concrete situation by collecting empirical data from the field and carrying out simulations.

7.3 Outlook

The proposed framework can serve humanitarian organizations as a starting point for developing their own strategic framework which considers their constraints. The proposed framework or frameworks adapted to a specific humanitarian organization can be applied to a specific context for developing operational plans for a given complex political emergency.

The proposed framework can also serve as a framework for analysis of logistics services provided by specific humanitarian organization in a specific context.

Applying the developed framework to specific humanitarian organizations and complex political emergencies will allow determining shortcomings and correct and possibly extend the framework.

Management of humanitarian assistance programmes could benefit from further research on suitable inventory control policies based on analysis of empirical data rather than heuristics.

Future benchmarking of the quality of current logistics and supply chain management in the context of humanitarian assistance and application of the proposed framework in a practical context would allow analysing and possibly quantifying the benefits of the framework. Identifying shortcomings would allow extending and improving the framework.

Developing similar frameworks for other categories of humanitarian assistance goods such as food and household items or water and sanitation items could be beneficial.

Finally the framework or at least some of its elements might be extendable to the field of development aid in peace times.

GLOSSARY

Active ingredient Any component that is intended to furnish pharmacological activity or other direct effect in the diagnosis, cure, mitigation, treatment, or prevention of disease (Willig, S.H. 2001, 9).

Bioavailability The rate and extent of availability of an active ingredient from a dosage form as determined by the concentration-time curve in the systemic circulation or by its excretion in urine (WHO 1997, Vol. 1, 64).

Certificate of analysis Certificate issued by the manufacturer for each batch of a drug product, stating the conformance of laboratory analysis results concerning identity and strength of all active ingredients with the stated pharmacopoeial standard (Willig, S.H. 2001, 182).

Cold chain A system of freezers, refrigerators, cold boxes, and other devices needed to maintain the proper temperature for vaccines from the point of manufacture to the point of administration (Quick, J.D. (ed.) 1997, 332).

Cold chain item/goods Drug products which require a cold chain in order to maintain temperatures between 2-8° Celsius without any interruption from the time of production until administration to the patient or use by a health professional.

Controlled drugs Narcotic drugs and psychotropic substances regulated by provisions of national drug laws (WHO 1997, Vol. 2, 160).

Dosage form The form of the completed drug product, e.g. tablet, capsule, elixir, injection, suppository (WHO 1997, Vol. 2, 65).

Drug product The dosage form in the final immediate packaging intended for marketing (USP 1995, 1962).

Drug regulatory authority An authority appointed by the government of a Member State to administer the granting of Marketing Authorizations for drug products in that country and which regulates the manufacture of drug products, the use and, in some cases, the manufacture of active pharmaceutical ingredients (WHO 1997a, 20).

Expiry date The date given on the individual container (usually on the label) of a drug product up to and including which the product is expected to remain within specifications, if stored correctly (WHO 1997, Vol. 1, 48).

Good Manufacturing Practice (GMP) GMPs (good manufacturing practices): Performance standards for pharmaceutical manufacturers established by WHO and many national governments; they include criteria for personnel, facilities, equipment, materials, manufacturing operations, labeling, packaging, quality control, and, in most cases, stability testing (Quick, J.D. (ed.) 1997, 181).

Health care facility Any dispensary, clinic, vaccination centre, first aid post, laboratory, hospital, orthopaedic centre or rehabilitation centre which provides preventive or curative health services to patients.

Hospital pack Original supplier packing containing larger quantities of health care goods (drug products, dressing material etc.) for further dispensing at pharmacies in health care facilities.

Internally displaced person (IDP) Person who is forced or obliged to flee from her/his home in particular as a result of or in order to avoid the effects of armed conflicts, situations of generalized violence, violations of human rights or natural or human-

made disasters, and who has not crossed an internationally recognized State border (UNHCR 2006, 365).

International Nonproprietary Name (INN) Unique and universally available (nonproprietary) designated name for identifying each pharmaceutical substance (WHO 2002a, i).

Multi-dose vial Vial with a rubber stopper which allows repeated withdrawal of doses of liquid drug products.

Multisource drug products Pharmaceutically equivalent drug products, which may or may not be therapeutically equivalent to the innovator drug product (WHO 1997, Vol. 1, 65). This term replaces the term "generic drug product".

Package insert Leaflet included in each package with detailed information on the drug product, all necessary information for the proper use of the product, prescription information, dosage, mode of administration, duration of use, adverse effects, overdosage information, contraindications, warnings, precautions, drug interactions and storage instructions (WHO 1997, Vol. 1, 36).

Packaging, primary Manufacturer packaging which is in immediate contact with drug products or other health care goods (WHO 2005, 10).

Packaging, secondary Manufacturer packaging with detailed labelling which consolidates several primary packaging units (WHO 2005, 10).

Pharmacopoeia Recognized standards for specifications, quality and testing procedures of pharmaceutical substances.

Primary Health Care Integral health care system which addresses the main health problems of entire communities and considers the overall social and economic situation.

Proprietary name Trade name assigned and used by the manufacturer (Willig, S.H. 2001, 216).

Refugee Person who, owing to a well-founded fear of being persecuted for reasons of race, religion, nationality, membership of a particular social group or political opinion, is outside the country of his nationality and is unable or, owing to such fear, is unwilling to avail himself of the protection of that country (Convention Relating to the Status of Refugees Art. 1 A. (2)).

Strength The concentration of the drug substance (USP 1995, 1908).

Unit-dose vial Vial which contains an amount of drug product which is sufficient only for a single dose.

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APPENDIX

Indicator	Source	Data	High income or DC	LDC	CPE 2005	LDC and CPE in 2005	LLDC
Corruption Perception Index (CPI)	Global corruption report 2006, p. 298	2005	5.53	3.34	2.92	2.58	2.26
Kaufmann-Kraay indicator Rule of Law	Global monitoring report, p. 212 ff.	est. 2004	0.51	-0.53	-0.77	-0.94	-1.30
Paved roads (% of total)	The Little Data Book 2005, p. 24-231	2002	95	38	47	34	19
Aircraft departures (thousands)	The Little Data Book 2005, p. 24-231	2002-03	306	44	79	39	8
Telephone mainlines per 1,000 people	HDR 2005, p. 262 ff.	2003	562	113	98	56	8
Cellular subscribers per 1,000 people	HDR 2005, p. 262 ff.	2003	710	134	174	108	16
Personal computers per 1,0000 people	The Little Data Book 2005, p. 24-231	2002	467	62	49	24	7
Internet users per 1,000 people	HDR 2005, p. 262 ff.	2003	477	53	47	32	4
Per capita total expenditure on health in USD	The World Health Report 2006, p. 186 ff.	2003	1,573	272	329	156	55
Adult literacy rate	HDR 2005, p. 219 ff.	2000-04	99	77	76	69	54
Under-five mortality rate	HDR 2005, p. 250 ff.	2003	6	88	85	99	156
Physicians (per 100,000 people)	HDR 2005, p. 236 ff.	1990-2004	321	75	122	57	16
Human Development Index	HDR 2005, p. 219 ff.	2003	0.91	0.69	0.63	0.58	0.52

Summary statistics from literature	Kotalik, J., and D. Rodriguez. Global Corruption Report 2006	The Little Data Book 2005.
Averages calculated from statistics tables	Sundberg, M. (ed.). Global Monitoring Report 2006	Denny, Ch. (ed.). Human Development Report 2005

The table above shows the data presented in table 2.1 together with the respective data source. Data in cells with white backgrounds is derived directly from the indicated literature source. Averages of data indicated in cells with grey backgrounds were calculated as shown in the table below. Averages were calculated for all countries for which data is available.

The term High Income Country, as used by the World Bank, is used interchangeably with the term Developed Country, which is used by UNCTAD. The UNCTAD Handbook of Statistics was used as a reference for classifying countries as developed countries, less developed countries or least developed countries (UNCTAD 2005).

All countries listed as medium or high intensity conflict in the Conflict Barometer 2005 (HIIK 2005) were considered as being affected by a complex political emergency. Since one country can be affected by different armed conflicts at the same, for example with different adversaries in different parts of the country, only 55 countries were affected by a total of 98 medium and highW intensity conflicts.

The Corruption Perception Index (CPI) is based on a public opinion survey carried out every year by Transparency International (Kotalik, J., and D. Rodriguez 2006).

The Kaufmann-Kray indicator is based on various assessments compiled by the World Bank and ranges from 0 (worst) to 10 (best). The indicator includes measures for the political stability and absence of violence, the effectiveness of governments and the rule of law (Sundberg, M. (ed.) 2006).

The United Nations Development Programme aggregates various indicators concerning income, education and health into the Human Human Development Index which ranges from 0 to 1 (Denny, Ch. (ed.) 2005).

No	Country	LDC	LLDC	CPE	LDC and CPE in 2005	Corruption Perception Index Score	Kaufmann-Kraay Rule of Law	Paved roads (% of total)	Aircraft departures (thousands)	Telephone lines per 1,000 people	Cellular subscribers per 1,000 people	Personal computers per 1,000 people	Internet users per 1,000 people	Per capita total expenditure on health at international dollar rate	Adult literacy rate	Under-five mortality rate	Physicians per 100,000 people	Human Development Index 2003
1	Albania	N	N	N	N	2.4	-0.80	39	4	83	358	11.7	10	366			139	
2	Australia	N	N	N	N	8.8	1.82	38.7	530	542	719	565.1	567	2,874			249	
3	Austria	N	N	N	N	8.7	1.76	100	128	481	879	369.3	462	2,306			324	
4	Belarus	N	N	N	N	2.6	-1.31	86.7	6	311	113	n.d.	141	570			450	
5	Belgium	N	N	N	N	7.4	1.47	78.2	133	489	793	318.1	386	2,828			418	
6	Bosnia and Herzegovina	N	N	N	N	2.9	-0.76	52.3	5	245	274	n.d.	n.d.	327			134	
7	Bulgaria	N	N	N	N	4	0.05	92	1	380	466	51.9	206	573			338	
8	Canada	N	N	N	N	8.4	1.75		1036	651	419	487	n.d.	2,989			209	
9	Croatia	N	N	N	N	3.4	0.07	84.6	20	n.d.	584	173.8	232	838			237	
10	Cyprus	N	N	N	N	5.7		62.2	17	572	744	269.9	337	1,143			298	
11	Czech Republic	N	N	N	N	4.3	0.69	100	52	360	965	177.4	308	1,302			343	
12	Denmark	N	N	N	N	9.5	1.91	100	91	669	883	576.8	541	2,762			366	
13	Estonia	N	N	N	N	6.4	0.91	24.8	8	341	777	440.4	444	682			316	
14	Finland	N	N	N	N	9.6	1.97	64	107	492	910	441.7	534	2,108			311	
15	Germany	N	N	N	N	8.2	1.66		845	657	785	484.7	473	3,001			362	
16	Greece	N	N	N	N	4.3	0.75	91.8	114	454	902	81.7	150	1,997			440	
17	Hungary	N	N	N	N	5	0.85	43.9	35	349	769	108.4	232	1,269			316	
18	Iceland	N	N	N	N	9.7		31.5	10	660	966	451.4	675	3,110			347	
19	Ireland	N	N	N	N	7.4	1.62	100	231	491	880	420.8	317	2,496			237	
20	Italy	N	N	N	N	5	0.74	100	328	484	1018	230.7	337	2,266			606	
21	Japan	N	N	N	N	7.3	1.39	77.1	639	472	679	382.2	483	2,244			201	
22	Kazakhstan	N	N	N	N	2.9	-0.98	93.9	20	141	n.d.	n.d.	n.d.	315			330	
23	Latvia	N	N	N	N	4.2	0.48	94.6	10	285	526	188	404	678			291	
24	Lithuania	N	N	N	N	4.8	0.60	89.7	10	239	630	109.7	202	754			403	
25	Luxembourg	N	N	N	N	8.5		100	41	797	1194	594.2	377	3,680			255	
26	Malta	N	N	N	N	6.6		90	14	521	725	255.1	n.d.	1,436			293	
27	Moldova	N	N	N	N	2.9	-0.65	86.3	4	219	132	17.5	80	177			269	
28	Netherlands	N	N	N	N	8.6	1.78	90	248	614	768	466.6	522	2,987			329	
29	New Zealand	N	N	N	N	9.6	1.93	64	247	448	648	413.8	526	1,893			223	
30	Norway	N	N	N	N	8.9	1.95	77.5	249	713	909	528.3	346	3,809			356	
31	Poland	N	N	N	N	3.4	0.51	68.3	73	307	451	142	232	745			220	
32	Portugal	N	N	N	N	6.5	1.16	86	117	411	898	134.4	n.d.	1,791			324	
33	Romania	N	N	N	N	3	-0.18	50.4	27	199	324	96.6	184	540			189	
34	Slovak Republic	N	N	N	N	4.3	0.49	87.3	7	241	684	180.4	256	777			325	
35	Slovenia	N	N	N	N	6.1	0.93	100	16	407	871	300.6	401	1,669			219	
36	Sweden	N	N	N	N	9.2	1.85	78.6	184	n.d.	980	621.3	n.d.	2,704			305	
37	Switzerland	N	N	N	N	9.1	1.98		189	727	843	708.7	398	3,776			352	
38	Turkmenistan	N	N	N	N	1.8	-1.43	81.2	25	77	n.d.	n.d.	n.d.	221			317	
39	Ukraine	N	N	N	N	2.9	-0.83	96.8	33	233	136	19	n.d.	305			297	
40	United States	N	N	N	N	7.6	1.58	58.8	7789	624	546	658.9	556	5,711			549	
41	Argentina	Y	N	N	N	2.8	-0.71	29.4	92	n.d.	n.d.	82	n.d.	1,067			301	
42	Bahamas	Y	N	N	N			57.4	25	415	367	n.d.	265	1,220			106	
43	Bahrain	Y	N	N	N	5.8		76.7	29	268	638	160.4	216	813			160	
44	Barbados	Y	N	N	N	6.9		98.6	n.d.	497	519	104.1	371	1,050			121	
45	Benin	Y	N	N	N	2.9	-0.47		n.d.	9	34	3.7	10	36				
46	Bhutan	Y	N	N	N		0.27		2	34	11	13.6	20	59			5	
47	Botswana	Y	N	N	N	5.9	0.73	55	8	75	297	40.7	n.d.	375			29	
48	Brazil	Y	N	N	N	3.7	0.00	5.5	487	223	264	74.8	n.d.	597			206	
49	Brunei	Y	N	N	N			100	12	n.d.	n.d.	76.7	n.d.	681			101	
50	Burkina Faso	Y	N	N	N	3.4	-0.62	16	1	5	19	2.1	4	68			4	
51	Cambodia	Y	N	N	N	2.3	-0.98	16.2	4	3	35	2.3	2	188			16	
52	Cape Verde	Y	N	N	N			78	9	156	116	79.7	44	185			17	
53	Central African Republic	Y	N	N	N		-1.44	2.7	1	n.d.	10	2	1	47			44	
54	Chad	Y	N	N	N	1.7	-1.15	0.8	1	n.d.	8	1.7	n.d.	51			63	
55	Chile	Y	N	N	N	7.3	1.16	20.2	83	221	511	119.3	272	707				
56	China	Y	N	N	N	3.2	-0.47		946	209	215	27.6	63	278				
57	Comoros	Y	N	N	N		-1.04	76.5	n.d.	17	3	5.8	6	25				
58	Costa Rica	Y	N	N	N	4.2	0.57	12	35	278	181	197.2	288	616			173	
59	Cuba	Y	N	N	N	3.8	-1.12	49	9	64	3	31.8	9	251				
60	Djibouti	Y	N	N	N		-0.61	12.6	n.d.	15	34	21.7	10	72			13	
61	Dominica	Y	N	N	N			50.4	n.d.	n.d.	n.d.	89.7	n.d.	320			49	
62	Dominican Republic	Y	N	N	N	3	-0.54	49.4	0	115	272	n.d.	102	335			188	
63	El Salvador	Y	N	N	N	4.2	-0.34	19.8	25	113	173	25.2	83	378			124	
64	Equatorial Guinea	Y	N	N	N	1.9			1	18	76	6.9	n.d.	179			25	
65	Eritrea	Y	N	N	N	2.6	-0.78	21.8	n.d.	9	0	2.9	7	50			3	
66	Fiji	Y	N	N	N	4		49.2	39	124	133	48.8	67	220				
67	French Polynesia	Y	N	N	N			n.d.	n.d.			285.1						
68	Gabon	Y	N	N	N	2.9	-0.51	9.9	8	29	224	22.4	26	255				
69	Gambia	Y	N	N	N	2.7	-0.32	35.4	n.d.	n.d.	n.d.	13.8	n.d.	96			4	
70	Ghana	Y	N	N	N	3.5	-0.16	18.4	3	13	36	3.8	n.d.	98				
71	Grenada	Y	N	N	N			61.3	n.d.	290	376	132.1	169	473			50	
72	Guatemala	Y	N	N	N	2.5	-0.96	34.5	7	77	165	14.4	n.d.	235			90	
73	Guinea-Bissau	Y	N	N	N		-1.26	10.3	1	8	1	n.d.	15	45			9	
74	Guyana	Y	N	N	N	2.5	-0.48	7.4	0	n.d.	n.d.	27.3	n.d.	283			48	
75	Honduras	Y	N	N	N	2.9	-0.61	20.4	n.d.	49	55	13.6	40	184			83	
76	Hong Kong, China	Y	N	N	N	8.3	1.42	100	87	559	1079	422	472					
77	Iran, Islamic Republic of	Y	N	N	N	2.9	-0.83	56.3	85	220	51	90.5	72	498				
78	Jamaica	Y	N	N	N	3.6	-0.32	70.1	24	n.d.	680	53.9	n.d.	216			85	
79	Jordan	Y	N	N	N	5.7	0.30	100	15	114	242	44.7	81	440			205	
80	Korea, Democratic Republic	Y	N	N	N		-1.15	6.4	1			n.d.		74			181	
81	Korea, Republic	Y	N	N	N	5	0.67	76.7	240	538	701	558	610	1,074			181	
82	Kuwait	Y	N	N	N	4.7	0.65	80.6	18	196	572	162.8	228	567			153	
83	Lesotho	Y	N	N	N	3.4	-0.03	18.3	0	16	47	n.d.	14	106			5	
84	Liberia	Y	N	N	N	2.2	-1.76	6.2	n.d.			n.d.		17				
85	Libya	Y	N	N	N	2.5	-0.65	57.2	6	136	23	23.4	29	327				
86	Macao, China	Y	N	N	N			100	14			260.9						
87	Madagascar	Y	N	N	N	2.8	-0.30	11.6	9	4	17	4.9	4	24			9	
88	Malawi	Y	N	N	N	2.8	-0.29	18.5	5	8	13	1.5	3	46			1	
89	Malaysia	Y	N	N	N	5.1	0.52	77.9	152	182	442	166.9	344	374			70	
90	Maldives	Y	N	N	N			n.d.	4	n.d.	n.d.	71.2	n.d.	364			78	
91	Mali	Y	N	N	N	2.9	-0.34	12.1	1	n.d.	23	1.4	n.d.	39				
92	Marshall Islands	Y	N	N	N			n.d.	4			53		477				
93	Mauritius	Y	N	N	N	4.2	0.84	98	15	285	267	116.5	123	430			85	
94	Mexico	Y	N	N	N	3.5	-0.26	32.8	287	160	295	82	120	582			171	
95	Micronesia, Federated States of	Y	N	N	N			17.5	n.d.			n.d.		270				
96	Mongolia	Y	N	N	N	3	0.18	3.5	7	56	130	77.3	58	140			267	
97	Mozambique	Y	N	N	N	2.8	-0.60	18.7	8	n.d.	23	4.5	n.d.	45			2	
98	Namibia	Y	N	N	N	4.3	0.22	12.8	6	66	116	99.3	34	359			30	
99	Nicaragua	Y	N	N	N	2.9	-0.65	11.4	1	37	85	27.9	n.d.	208			164	
100	Niger	Y	N	N	N	2.4	-0.92	7.9	1	n.d.	6	0.6	n.d.	30				

No	Country	LDC	LLDC	CPE	LDC and CPE in 2005	Corruption Perception Index Score	Kaufmann-Kraay Rule of Law	Paved roads (% of total)	Aircraft departures (thousands)	Telephone lines per 1,000 people	Cellular subscribers per 1,000 people	Personal computers per 1,000 people	Internet users per 1,000 people	Per capita total expenditure on health at international dollar rate	Adult literacy rate	Under-five mortality rate	Physicians per 100,000 people	Human Development Index 2003
101	Oman	Y	N	N	N	6.3	0.98	30	28	88	228	35	n.d.	419				
102	Palestinian territory	Y	N	N	N	2.6	-0.95	n.d.	n.d.	87	133	36.2	40					
103	Panama	Y	N	N	N	3.5	-0.04	34.6	26	122	268	38.3	62	555			168	
104	Papua New Guinea	Y	N	N	N	2.3	-0.82	3.5	18	n.d.	n.d.	58.7	n.d.	132			5	
105	Paraguay	Y	N	N	N	2.1	-1.09	50.8	11	46	299	34.6	20	301			117	
106	Peru	Y	N	N	N	3.5	-0.63	13.4	36	67	106	43	104	233				
107	Puerto Rico	Y	N	N	N		0.74	94	n.d.			n.d.						
108	Qatar	Y	N	N	N	5.9		90	24	261	533	180.3	199	685				
109	Rwanda	Y	N	N	N	3.1	-0.90	8.3	n.d.	n.d.	16	n.d.	n.d.	32			2	
110	Samoa	Y	N	N	N			42	9	73	58	6.7	n.d.	209				
111	Sao Tome and Principe	Y	N	N	N		-0.55	68.1	1	46	32	n.d.	99	93				
112	Senegal	Y	N	N	N	3.2	-0.20	29.3	2	22	56	21.2	22	58			8	
113	Seychelles	Y	N	N	N	4		84.5	19	256	595	160.8	n.d.	599			132	
114	Sierra Leone	Y	N	N	N	2.4	-1.10	8	0	n.d.	n.d.	n.d.	n.d.	34			7	
115	Singapore	Y	N	N	N	9.4	1.82	100	64	450	852	622	509	1,156			140	
116	Solomon Islands	Y	N	N	N		-1.15	2.5	10	13	3	40.5	5	87			13	
117	South Africa	Y	N	N	N	4.5	0.32	20.9	147	n.d.	364	72.6	n.d.	669			69	
118	St. Kitts and Nevis	Y	N	N	N			42.5	n.d.	n.d.	n.d.	191.5	n.d.	670				
119	St. Lucia	Y	N	N	N			5.2	n.d.	n.d.	n.d.	150	n.d.	294				
120	St. Vincent and the Grenadines	Y	N	N	N			70	n.d.	273	529	119.7	n.d.	384				
121	Suriname	Y	N	N	N	3.2		26	4	152	320	45.5	44	309			45	
122	Syrian Arab Republic	Y	N	N	N	3.4	-0.40	14.2	7	n.d.	68	19.4	35	116			140	
123	Tanzania	Y	N	N	N	2.9	-0.49	4.2	6	4	25	5.7	7	29			2	
124	Timor-Leste	Y	N	N	N			n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	125				
125	Tonga	Y	N	N	N			27	5	n.d.	n.d.	20.2	n.d.	300				
126	Trinidad and Tobago	Y	N	N	N	3.8	0.17	51.1	18	n.d.	n.d.	79.5	n.d.	532			79	
127	Tunisia	Y	N	N	N	4.9	0.24	65.4	19	118	197	40.5	64	409			70	
128	United Arab Emirates	Y	N	N	N	6.2	0.85	100	70	281	736	129	275	623			202	
129	Uruguay	Y	N	N	N	5.9	0.42	90	7	n.d.	n.d.	110.1	n.d.	824			365	
130	Vanuatu	Y	N	N	N			23.9	1	31	38	14.8	36	110			11	
131	Vietnam	Y	N	N	N	2.6	-0.59	25.1	48	54	34	9.8	43	164				
132	Zambia	Y	N	N	N	2.6	-0.54	22	5	8	22	8.5	6	51			7	
133	Armenia	N	N	Y	N	2.9	-0.58	96.8	4	148	30	15.8	37	302	99.4	33	353	0.76
134	Azerbaijan	N	N	Y	N	2.2	-0.85	92.4	9	114	128	n.d.	n.d.	140	98.8	91	354	0.73
135	France	N	N	Y	N	7.5	1.33	100	696	566	696	347.1	366	2,902	99	5	329	0.94
136	Georgia	N	N	Y	N	2.3	-0.87	93.5	2	134	145	31.6	24	174	99	45	391	0.73
137	Israel	N	N	Y	N	6.3	0.77	100	36	458	961	242.6	n.d.	1,911	96.9	6	391	0.92
138	Kyrgyz Republic	N	N	Y	N	2.3	-1.04	91.1	5	76	27	12.7	38	161	98.7	68	268	0.70
139	Macedonia	N	N	Y	N	2.7	-0.44	63.8	2	252	372	n.d.	60	389	96.1	11		0.80
140	Russian Federation	N	N	Y	N	2.4	-0.70	67.4	351	253	249	88.7	n.d.	551	99.4	21	417	0.80
141	Serbia and Montenegro	N	N	Y	N	2.8	-0.72	59.3	22			27.1		373	n.d.			n.d.
142	Spain	N	N	Y	N	7	1.12	99	519	429	916	196	239	1,853	97.7	4	320	0.93
143	Tajikistan	N	N	Y	N	2.1	-1.18		7	37	7	n.d.	1	71	99	118	218	0.65
144	United Kingdom	N	N	Y	N	8.6	1.71	100	891	n.d.	912	405.7	n.d.	2,389		6	549	0.94
145	Uzbekistan	N	N	Y	N	2.2	-1.30	87.3	22	67	13	n.d.	19	159	99	69	289	0.69
146	Algeria	Y	N	Y	Y	2.8	-0.73	68.9	44	69	45	7.7	n.d.	186	69.8	41	85	0.72
147	Belize	Y	N	Y	Y	3.7		17	n.d.	113	205	138.3	n.d.	309	76.9	39	105	0.75
148	Bolivia	Y	N	Y	Y	2.5	-0.55	6.6	29	72	152	22.8	n.d.	176	86.5	66	73	0.69
149	Cameroon	Y	N	Y	Y	2.2	-1.00	12.5	10	n.d.	66	5.7	n.d.	64	67.9	166	7	0.50
150	Colombia	Y	N	Y	Y	4	-0.70	14.4	172	179	141	49.3	53	522	94.2	21	135	0.79
151	Congo	Y	N	Y	Y	2.3	-1.18	9.7	5	2	94	4.3	4	23	82.8	108	7	0.51
152	Côte d'Ivoire	Y	N	Y	Y	1.9	-1.42	9.7	1	14	77	9.3	14	57	48.1	192	9	0.42
153	Ecuador	Y	N	Y	Y	2.5	-0.71	18.9	13	122	189	31.1	46	220	91	27	148	0.76
154	Egypt	Y	N	Y	Y	3.4	-0.02	78.1	42	127	84	21.9	44	235	55.6	39	212	0.66
155	India	Y	N	Y	Y	2.9	-0.99	57.3	264	46	25	7.2	17	82	61	87	51	0.60
156	Indonesia	Y	N	Y	Y	2.2	-0.91	58	156	39	87	11.9	38	113	87.9	41	16	0.70
157	Iraq	Y	N	Y	Y	2.2	-1.97	84.3	n.d.			8.3		64				
158	Kenya	Y	N	Y	Y	2.1	-0.98	12.1	27	10	50	6.4	n.d.	65	73.6	123	13	0.47
159	Lebanon	Y	N	Y	Y	3.1	-0.32	84.9	11	200	234	80.5	143	730	86.5	31	325	0.76
160	Morocco	Y	N	Y	Y	3.2	-0.05	56.4	35	40	244	19.9	33	218	50.7	39	48	0.63
161	Nigeria	Y	N	Y	Y	1.9	-1.44	30.9	9	7	26	7.1	6	51	66.8	198	27	0.45
162	Pakistan	Y	N	Y	Y	2.1	-0.78	59	45	27	18	4.2	n.d.	48	48.7	103	66	0.53
163	Philippines	Y	N	Y	Y	2.5	0.62	9.5	56	41	270	27.7	n.d.	174	92.6	36	116	0.76
164	Saudi Arabia	Y	N	Y	Y	3.4	0.20	29.9	108	155	321	130.2	67	578	79.4	26	140	0.77
165	Sri Lanka	Y	N	Y	Y	3.2	-0.03	81	13	49	73	13.2	13	121	90.4	15	43	0.75
166	Swaziland	Y	N	Y	Y	2.7	-0.95	n.d.	2	44	84	28.7	26	324	79.2	153	18	0.50
167	Thailand	Y	N	Y	Y	3.8	-0.05	98.5	94	105	394	39.8	111	260	92.6	26	30	0.78
168	Turkey	Y	N	Y	Y	3.5	0.04	41.6	104	268	394	44.6	85	528	88.3	39	124	0.75
169	Venezuela	Y	N	Y	Y	2.3	-1.10	33.6	106	111	273	60.9	60	231	93	21	194	0.77
170	Zimbabwe	Y	N	Y	Y	2.6	-1.53	47.4	4	n.d.	n.d.	52.7	n.d.	132	90	126	6	0.51
171	Afghanistan	Y	Y	Y	Y	2.5	-1.81	13.3	3			n.d.		26	n.d.			n.d.
172	Angola	Y	Y	Y	Y	2	-1.33	10.4	5	7	n.d.	1.9	n.d.	49	66.8	260	8	0.45
173	Bangladesh	Y	Y	Y	Y	1.7	-0.86	9.5	7	5	10	7.8	2	68	41.1	59	23	0.52
174	Burundi	Y	Y	Y	Y	2.3	-1.50	n.d.	1	3	9	1.8	2	15	58.9	190	5	0.38
175	Democratic Republic of Congo	Y	Y	Y	Y	2.1	-1.74	n.d.	5	n.d.	19	n.d.	n.d.	14	65.3	205	7	0.39
176	Ethiopia	Y	Y	Y	Y	2.2	-1.00	12	27	6	1	2.2	1	20	41.5	169	3	0.37
177	Guinea	Y	Y	Y	Y		-1.09	16.5	1	3	14	5.5	5	95	41	160	9	0.47
178	Haiti	Y	Y	Y	Y	1.8	-1.66	24.3	n.d.	17	38	n.d.	18	84	51.9	118	25	0.48
179	Laos	Y	Y	Y	Y	3.3	-1.27	44.5	7	12	20	3.5	3	56	68.7	91	59	0.55
180	Mauritania	Y	Y	Y	Y		-0.62	11.3	2	14	127	10.8	4	59	51.2	183	14	0.48
181	Myanmar	Y	Y	Y	Y	1.8	-1.62	n.d.	21	7	1	5.6	1	51	89.7	107	30	0.58
182	Nepal	Y	Y	Y	Y	2.5	-0.82	30.8	13	16	2	3.7	n.d.	64	48.6	82	5	0.53
183	Somalia	Y	Y	Y	Y	2.1	-2.31	11.8	n.d.			n.d.		n.d.	n.d.			n.d.
184	Sudan	Y	Y	Y	Y	2.1	-1.59	36.3	8	27	20	6.1	9	54	59	93	16	0.51
185	Togo	Y	Y	Y	Y		-1.01	31.6	1	12	44	32	42	62	53	140	6	0.51
186	Uganda	Y	Y	Y	Y	2.5	-0.79	6.7	0	2	30	4	5	75	68.9	140	5	0.51
187	Yemen	Y	Y	Y	Y	2.7	-1.11	11.5	15	n.d.	n.d.	7.4	n.d.	89	49	113	22	0.49
Averages	**High income or DC**					**5.53**	**0.51**		**306**					**1573**			**321**	
	LDC					**3.34**	**-0.53**	**38**	**44**			**62**		**272**			**75**	
	CPE 2005					**2.92**	**-0.77**	**47**	**79**	**98**	**174**	**49**	**47**	**329**	**76**	**85**	**122**	**0.63**
	LDC and CPE in 2005					**2.58**	**-0.94**	**34**	**39**	**56**	**108**	**24**	**32**	**156**	**69**	**99**	**57**	**0.58**
	LLDC					**2.26**	**-1.30**	**19**	**8**			**7**		**55**			**16**	